

1988 Annual Report on Alaska's Mineral Resources

U.S. GEOLOGICAL SURVEY CIRCULAR 1023



Prepared in cooperation with the Bureau of Land Management,
the Fish and Wildlife Service, the Minerals Management Service,
the National Park Service, the U.S. Bureau of Mines,
the U.S. Forest Service, and the Department of Energy,
as mandated by Section 1011 of the Alaska National Interest
Lands Conservation Act, Public Law 96-487, of December 2, 1980



CONTRIBUTORS

DEPARTMENT OF THE INTERIOR

Bureau of Land Management

John Santora

Fish and Wildlife Service

Charles Diters

Minerals Management Service

Noreen Clough

National Park Service

Cordell Roy

U.S. Bureau of Mines

Steven Fechner

U.S. Geological Survey

Kendell Dickinson

Leslie Magoon

Gary Stricker

Warren Yeend

M. Elizabeth Yount

DEPARTMENT OF AGRICULTURE

U.S. Forest Service

Roger Griffin

DEPARTMENT OF ENERGY

William Gwilliam

Rodney Malone

Marshall Reed

Harold Shoemaker

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White Mountains National Recreation Area, subject of a mineral resource assessment by the U.S. Bureau of Mines, the U.S. Geological Survey, and the Alaska Division of Geological and Geophysical Surveys. Photograph by M.D. Balen.

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DIEDRA BOHN, Editor

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DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director



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Acronyms and Abbreviations

AAPG	American Association of Petroleum Geologists
ACC	Alaska Crude Corporation
ADGGS	Alaska Division of Geological and Geophysical Surveys
AFOC	Alaskan Field Operations Center
A-J	Alaska-Juneau
AMRAP	Alaska Mineral Resource Assessment Program
ANILCA	Alaska National Interest Lands Conservation Act
ANWR	Arctic National Wildlife Refuge
ANGTS	Alaska Natural Gas Transport System
AORIS	Arctic and Offshore Research Information System
APA	Alaska Power Authority
BLM	Bureau of Land Management
B/MIS	Bibliographic/Management Information System
CIRI	Cook Inlet Region, Incorporated
DOE	Department of Energy
EIS	Environmental Impact Statement
FPGP	Favorable Petroleum Geological Province
FWS	Fish and Wildlife Service
KIC	Kaktovik Inupiat Corporation
MAS	Minerals Availability System
MILS	Minerals Industry Location System
MMS	Mineral Management Service
MRDS	Mineral Resources Data System
NEPA	National Environmental Policy Act
NPRA	National Petroleum Reserve in Alaska
NPS	National Park Service
PCB	Polychlorinated Biphenyl
PGM	Platinum-Group Metals
REE	Rare-Earth Element
SEMS	Seafloor Earthquake Measurement System
SEPM	Society of Economic Paleontologists and Mineralogists
TACT	Trans-Alaska Crustal Transect
TAGS	Trans-Alaska Gas System
TAPS	Trans-Alaska Pipeline System
USBM	U.S. Bureau of Mines
USFS	U.S. Forest Service
USGS	U.S. Geological Survey

1988 Annual Report on Alaska's Mineral Resources

Diedra Bohn, *Editor*

SUMMARY

Section 1011 of the Alaska National Interest Lands Conservation Act (ANILCA) of 1980 requires that "On or before October 1, 1982, and annually thereafter, the President shall transmit to Congress all pertinent public information relating to minerals in Alaska gathered by the United States Geological Survey, Bureau of Mines, and any other Federal agency." This report has been prepared in response to that requirement.

The U.S. Geological Survey (USGS) and the U.S. Bureau of Mines (USBM) are the principal Federal agencies that publish information about mineral resources in Alaska. Their reports and data are commonly used by other Federal agencies in decisionmaking on land use, access, environmental impacts, and mining claim evaluation. Because of the time required for sample analysis, data synthesis, and the publication process, scientific reports are generally issued a year or more after the initial sample and data collection. Other sources of information include Federal and State publications, trade and professional journals, newspaper articles, presentations at public meetings and hearings, and press releases.

This circular is the seventh in a series of annual ANILCA reports. The report provides information about current Alaskan mineral projects and events during 1987 and in the early months of 1988; the emphasis is on Federal activity. In general, the report addresses only onshore areas of Alaska.

Information is provided for two broad categories of minerals: energy resources and nonfuel-mineral resources.

Energy Resources

OIL AND GAS

Oil and gas production increased slightly in Alaska during 1987, and as in past years, were the most valuable commodities produced in the State. For the first time, production data, although unofficial, rates Alaska over Texas as the top oil-producing state, with Alaskan fields supplying about 23 percent of the domestic oil production.

Conditions in the 1987 petroleum industry were somewhat improved over 1986. The price of Alaska North Slope

crude oil followed an upward trend during 1987. Development of existing oil fields was on or ahead of schedule, with the Endicott field beginning production in October, the Swanson River oil field completing 30 years of production, an enhanced oil recovery program implemented at the McArthur River field, and an additional gas field drilled at the Cannery Loop field near Kenai. Industry activity in 1987 included the drilling of three exploratory wells and 200 development wells. At Prudhoe Bay, the largest oil field in the U.S., the five-billionth barrel of oil, produced in March, marked the halfway point for recoverable reserves. Also on the North Slope in 1987, production was increased at the Kuparuk River field, the second largest oil field in the U.S., and production continued at the Lisburne field, but the Milne Point field remained shut-down, awaiting an increase in oil prices.

Two competitive onshore oil and gas lease sales held by the State of Alaska in 1987 attracted \$6.9 million in high bids for 219,000 acres of land.

The USGS continued to focus its energy-resource studies on the North Slope of Alaska, including participation in a seminar on the petroleum geology of the 1002 area of the Arctic National Wildlife Refuge (ANWR), compilation of technical papers on the National Petroleum Reserve in Alaska (NPRA), and research on natural-gas hydrates. Elsewhere in the State, the USGS completed a deep-gas study in the Yukon Flats sedimentary basin and continued research on the geology and petroleum potential of the sedimentary basins in interior Alaska.

In 1987, the Bureau of Land Management (BLM) continued its oil and gas leasing program on two areas south of the Brooks Range, and again postponed a lease sale in the NPRA, due to low demand. The BLM also provided the Fish and Wildlife Service (FWS) with petroleum assessments for three national wildlife refuges, and published the draft Environmental Impact Statement for the proposed Trans-Alaska Gas System (TAGS).

In keeping with its mission to protect fish, wildlife, and habitat, the FWS monitored and evaluated the environmental impact of petroleum-related activities in the Kenai Wildlife Refuge, prepared special-use permits for surface geological work in three wildlife refuges, and reviewed permit applications to the U.S. Army Corps of Engineers in order to recommend measures to minimize habitat losses. In addition, the FWS released final management plans for the lands in nine national wildlife refuges.

of ANILCA conservation units and the locations of lands under Federal management are shown in figure 1.

MINERAL PROGRAMS

Department of the Interior

U.S. GEOLOGICAL SURVEY

As directed by Section 1010 of ANILCA, the Secretary of the Interior requires an assessment of "the oil, gas, and other mineral potential on all public lands in the State of Alaska in order to expand the data base with respect to the mineral potential of such lands." AMRAP is an example of the response of the USGS to this legislation. The goal of this program is a systematic investigation of the State's mineral resources, through four progressively more detailed levels of study. Studies at levels I and II are general and cover large areas. Studies at level III draw on many geologic disciplines to produce resource assessments at scales of 1:250,000 and 1:125,000. Level IV studies consist of detailed studies of specific mining districts, mineral deposits, or topics related to the genesis of mineral deposits. In 1987, level III studies were in progress in 29 quadrangles, and a total of 37 level IV studies were under way (fig. 2). These studies are used to help determine the distribution and potential of national mineral and energy endowments and to aid in formulating policy affecting resource and land management, and in improving resource assessment technology to minimize potential impacts from development. These studies also help industry locate new mineral deposits and develop concepts, models, and techniques to identify such deposits. USGS publications are frequently used by industry as a source of information about known mineral deposits in the State.

The USGS carries on its work in Alaska through several programs in addition to AMRAP. Among the programs active in 1987 were: (1) the Earthquake Hazards Reduction Program, which seeks to mitigate earthquake losses through providing data and evaluations for land-use planning, engineering, and emergency preparations; (2) the Volcano Hazards Program, which includes studies on the assessment, reduction, and prediction of volcanic hazards; (3) the Geologic Framework Program, involving both general and specialized research on the regional geology of the State; (4) studies of mineral resources on public lands; (5) the Development of Assessment Techniques Program, whose goal is improvement of the ability to identify and evaluate mineral resources; (6) the Critical and Strategic Minerals Program, for identifying the potential of these resources to meet national military and economic needs; (7) the Sedimentary Basins Program, which conducts studies of depositional, structural, diagenetic, and thermal processes to

predict and evaluate water, mineral, and petroleum resources; and (8) the Geothermal Investigations Program, which focuses on studies of the nature, distribution, and energy potential of these resources nationally. The TACT program applies a multidisciplinary approach to study the Earth's crust along a corridor from the Pacific Ocean to the Arctic Ocean. This program is coordinated with the Trans-Alaska Lithosphere Investigation, which utilizes earth scientists from the ADGGS, the University of Alaska, other universities, and private industry. The mineral-related aspects of many of these programs are more fully described in later sections of this report.

Economic-geologic information for mineral occurrences in the United States and worldwide is available through the USGS Mineral Resources Data System (MRDS) computerized files. In Alaska, recently updated records focusing on metallic minerals contain 2,051 entries for forty 1:250,000-scale quadrangles in the south-central and southeastern areas of the State. Data in these files include mineral-deposit size, type, description, location, reserves, and pertinent literature references for known or potentially locatable mineral resources (see Leonard and Huber, 1987). Geologic information from the Alaska MRDS files can be used to complement economically oriented data from the USBM's Mineral Availability and Mineral Industry Location Systems computerized files, discussed in the next section. Further MRDS information can be obtained from Donald F. Huber, Central and Western Regional Representative, U.S. Geological Survey, MS 984, 345 Middlefield Road, Menlo Park, CA 94025.

U.S. BUREAU OF MINES

During 1987, the Alaska Field Operations Center (AFOC) of the USBM was active in the programs listed below; further information on the scope and nature of these programs can be found in appendix 2.

Mineral land assessment.—The USBM's major emphasis in Alaska is to develop area- and commodity-oriented mineral assessments. A major part of this program focuses on evaluations of mining districts in Alaska, with assessments of the type, quantity, distribution, reserves, and beneficiation potential of specific mineral deposits. The program also centers on critical- and strategic-mineral studies throughout the State. USBM geologists locate, map, and estimate the size and grade of mineral deposits, and collect samples for metallurgic research.

Minerals availability.—The two computerized components of this program are the Minerals Availability System (MAS) and the Minerals Industry Location System (MILS) data bases. The MAS contains information on reserve estimates, mineral extraction and beneficiation methodologies, environmental constraints on mining, and cost analyses for selected major mineral deposits. The

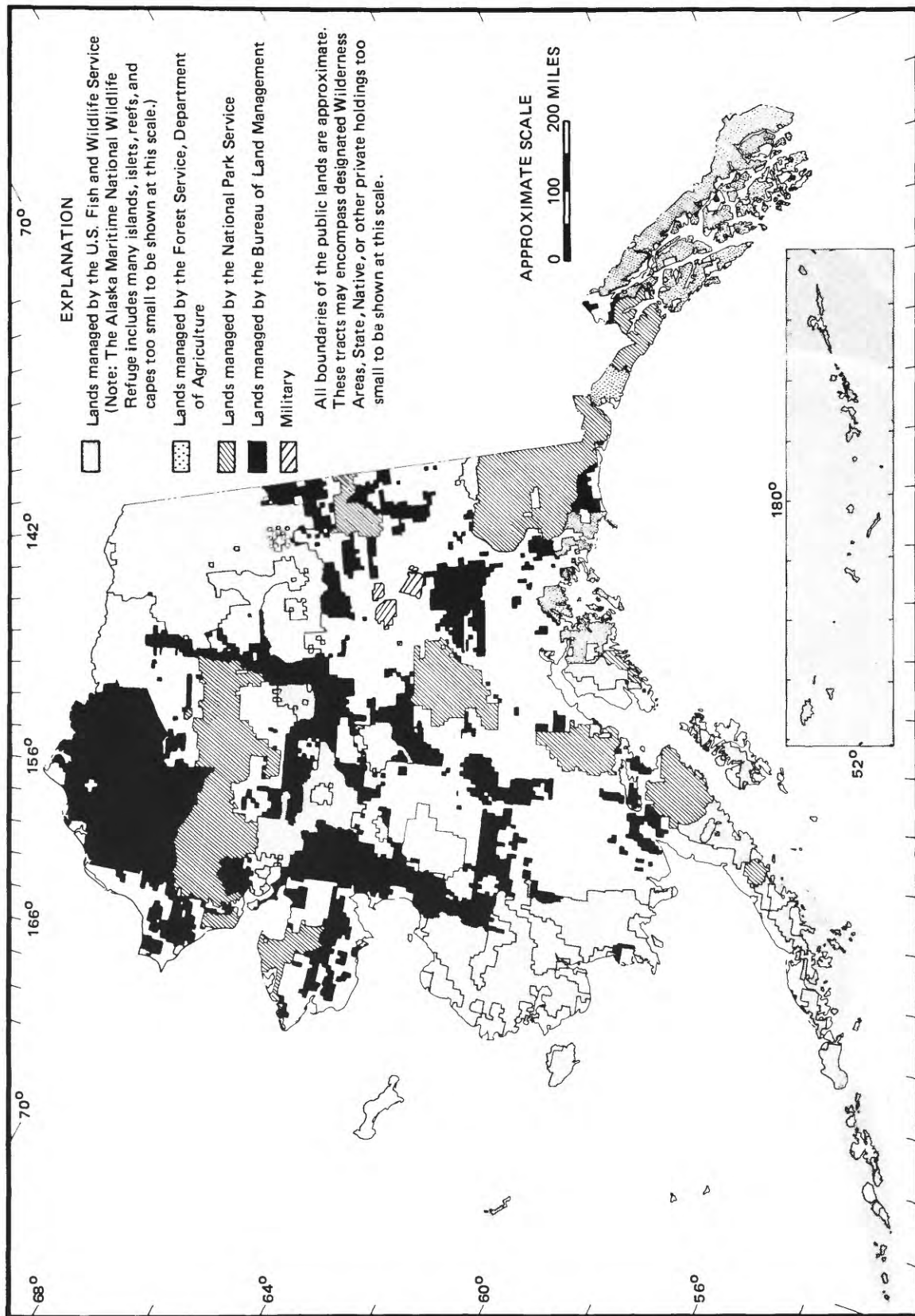


Figure 1. Federal land ownership in Alaska (boundaries as of June 1987).

MILS lists basic information on the identification and location of known mineral deposits.

Minerals policy and analysis.—This program compiles analyses of mineral data with respect to local and national needs. Technical, institutional, political, social, and economic parameters are used to identify mineral issues.

State mineral activities.—A USBM Alaskan State Mineral Officer compiles and analyzes mineral data to report on activities and trends within Alaska's mining industry.

Mineral research.—In addition to mineral assessment, the USBM and university research centers are attempting to provide solutions to mineral recovery problems. The Tuscaloosa Research Center (Alabama) is involved in field demonstration projects in Alaska, applying techniques to reduce turbidity in waters discharged from placer mining operations. The Salt Lake City Research Center (Utah) examines bulk samples of ore from selected sites for mineral content and amenability to concentration and extraction of the mineral values.



Figure 2. Mt. Igikpak pluton in the Brooks Range, site of granitic orthogneiss sampled for detailed Nd-Sm isotopes and U-Pb radiometric dating for the Northwestern Alaska crustal study project; a level IV study of AMRAP. Photograph by S.W. Nelson.

The USBM established a technology transfer office in Anchorage to increase application of technology developed at the Bureau's mining and mineral processing research centers to selected mineral industry problems in Alaska.

BUREAU OF LAND MANAGEMENT

The principal activities of the BLM that are related to Alaska's onshore mineral and energy resources are: (1) development of the terms and conditions, through the planning process and environmental review, in accordance with the National Environmental Policy Act (NEPA), for mineral exploration and development on BLM lands, (2) issuance of mineral leases and management of lease activity on Federal lands, coordinating with the responsible surface managing agency where appropriate, (3) recording of mining claims and determination of the validity of claims for mineral patents, and (4) regulation of mining activities on BLM lands to protect the environment. The BLM is also responsible for enforcing environmental and technical stipulations of the Agreement and Grant of Right of Way for the Trans-Alaska Pipeline. The overall goal is to maintain a continuous supply of energy with minimal environmental impact. In addition, the BLM issues land-use authorizations and conducts mineral and material sales to support preconstruction activities for the planned natural-gas pipeline and other projects.

Administrative responsibilities for minerals require close coordination with other surface-management agencies. Generally, in the case of onshore leases, the BLM issues leases and integrates leasing with other land uses in cooperation with the surface-management agency. After a lease is issued, the BLM assumes jurisdiction of exploratory and development activities in cooperation with the land manager to assure proper surface and subsurface protections.

FISH AND WILDLIFE SERVICE

Mineral activities on FWS land in Alaska must conform to the agency's mission of protecting fish and wildlife, and their habitat. In Alaska, FWS activities include administration of 77 million acres of national wildlife refuge land, fish and wildlife research, law enforcement, and habitat protection through agency review of and comments on permit requests, environmental impact statements, and other items. The FWS has an environmental-contaminants program that includes sampling and reporting on contaminants in waters, sediments, and organisms affected by oil and gas exploration and development, placer mining, and other mineral activities.

The locations of the 16 national wildlife refuges managed by the FWS in Alaska are shown in figure 3.

MINERALS MANAGEMENT SERVICE

Created in 1982, the Minerals Management Service (MMS) has a twofold mission: to collect and disburse revenues generated from minerals leases on Federal and Indian lands, and secondly, to manage the Interior Department's Outer Continental Shelf (OCS) leasing program.

The responsibility of MMS for onshore Alaskan minerals is limited to the collection of royalties, bonuses, and rents from Federal and certain Native lands. Royalties and other revenues generated from minerals leases on Alaska onshore Federal and Native lands are largely derived from leases on the Kenai National Wildlife Refuge's Swanson River oil and gas field. Total revenues generated by these activities in Alaska for calendar year 1986 (for all minerals) were \$13,696,592.

As it does in the lower 48 states, the MMS also leases Alaskan offshore areas for oil and gas exploration and production, and has the authority to lease OCS lands for ocean mining of hard minerals.

NATIONAL PARK SERVICE

The National Park Service (NPS) does not "manage minerals" in the same sense as other Federal agencies because the vast majority of park units are closed by law to mineral disposition. The NPS is directed by its Organic Act and other Federal law to protect park resources and, more specifically, to protect them from significant adverse impacts resulting from mineral exploration and development activities. Minerals management programs of the NPS relate to the conduct of activities which result from the exercise of valid existing mineral rights and the need to protect park resources. Valid existing rights are State, Native, or other private mineral or fee lands or interests in lands whose ownership was typically established at the time the park unit was created. Examples of valid existing mineral rights which are regulated by the NPS are patented or valid unpatented mining claims and non-Federal oil and gas rights.

The NPS minerals management programs in Alaska include mineral examinations to determine claim validity (fig. 4), evaluation of proposed plans of operations for completeness, engineering analysis and assessment of proposed plans of operations, bonding, monitoring, and reclamation of approved operations. In Alaska, major programs have been undertaken to survey, aerially photograph, and map mining claims; to prepare topographic maps of mining claims (1 inch = 100 feet; 10-foot contour intervals); and to perform hydrological monitoring and reclamation research. A brief summary of NPS regulations and programs governing mineral-related activities is presented in appendix 2.

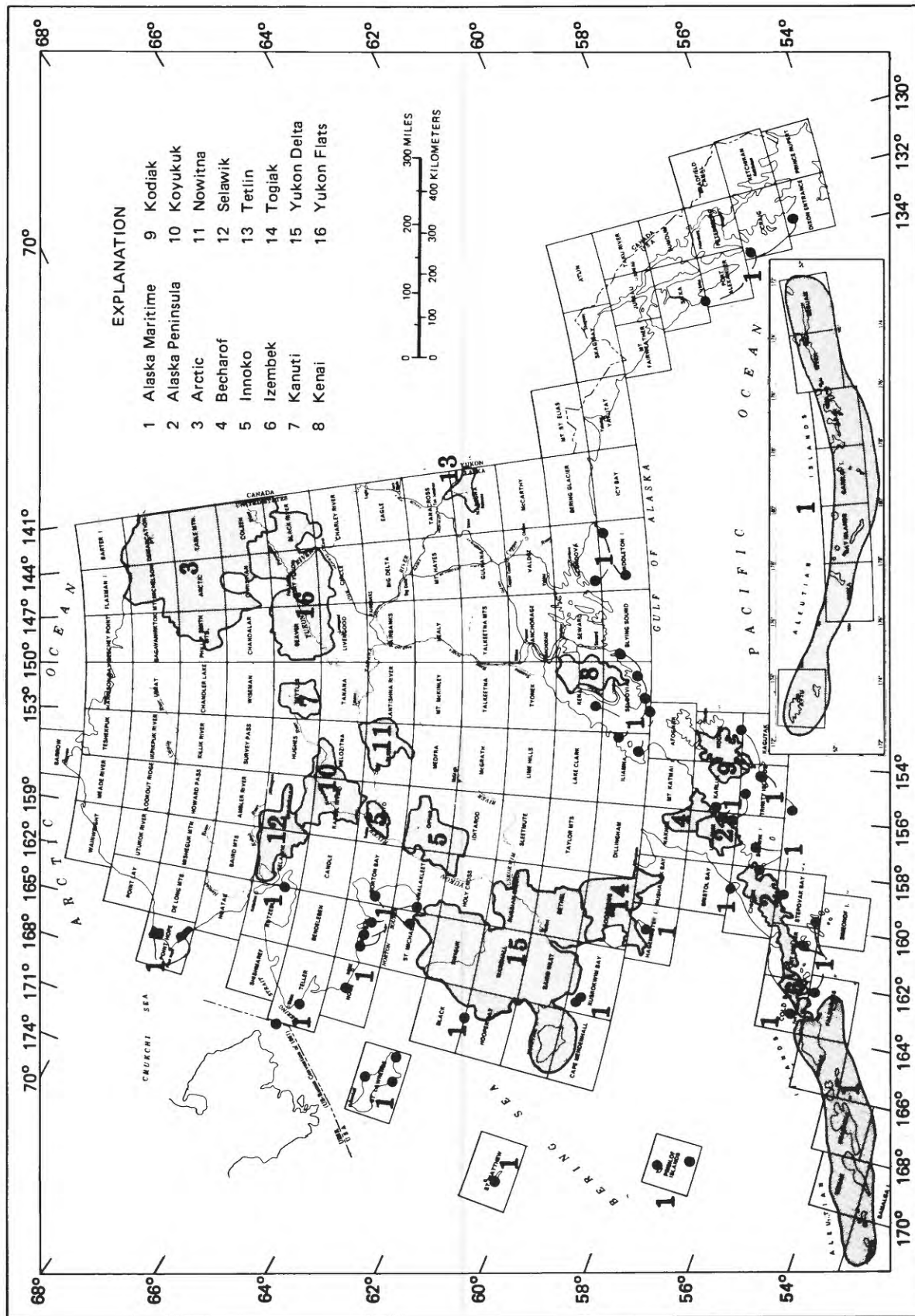


Figure 3. National wildlife refuges in Alaska.

Department of Agriculture

U.S. FOREST SERVICE

Under a memorandum of understanding with the BLM, the USFS jointly administers the general mining laws on its own lands in Alaska. An example of this joint responsibility is the patent issued to U.S. Borax and Chemical Co. for mining claims at their Quartz Hill deposit near Ketchikan. The USFS recommended issuance of this patent on the basis of favorable findings in the mineral report prepared by USFS mineral examiners.

The USFS cooperates with Department of the Interior agencies, particularly the BLM, in issuing mineral leases and assuring mitigation of surface impacts of lease activities. The USFS also cooperates with the State of Alaska and the private sector in development of energy and mineral resources on inholdings. One such inholding is the Bering River

coal field, under consideration for possible development by Chugach Alaska, Inc., and others in a consortium.

In Alaska, 23 million acres of land is administered by the USFS (fig. 1), whose regional office is in Juneau. Offices for Chugach National Forest are in Anchorage, Seward, and Cordova, and for Tongass National Forest in Sitka, Ketchikan, and Petersburg.

Department of Energy

In Alaska, the DOE is focusing its efforts on petroleum, coal, and geothermal resources. The DOE in Alaska administers current petroleum acts and congressional mandates relating to energy, monitors grants, and oversees contracts for energy-resource studies. DOE funding helps to support USGS resource-assessment studies and research by the ADGGS and the University of Alaska.



Figure 4. National Park Service geologists process placer samples during a mineral examination on Sam Creek in Yukon-Charley Rivers National Preserve. Photograph by L. Griffiths.

To develop a better understanding of both conventional and unconventional petroleum resources and to provide fundamental information to accelerate use of these resources, the DOE focuses on investigating resources and technologies that continue to expand the body of essential basic scientific knowledge of conventional and heavy petroleum, shale oil, tar sands, gas hydrates, and deep-source gas. Gas hydrates, deep-source gas, and Arctic offshore energy are specific targets of DOE research in Alaska.

The DOE is working to evaluate Alaskan coal in terms of its contribution to the total resources of the Nation. Coal research currently centers on utilization methods suitable to Alaskan coals and conditions.

The DOE has established several computerized data bases, including the Arctic and Offshore Research Information System (AORIS), which is designed to provide scientific oil- and gas-related information for use by the Arctic energy community. AORIS is composed of a directory of 85 energy-related data bases, a bibliography containing approximately 9,000 citations, and a quantitative data base containing approximately 600 data sets, in both tabular and graphical formats, on sea-ice characteristics.

The DOE's Geothermal Energy Program provided funds in Alaska to the University of Alaska's Geophysical Institute and the ADGGS for research about specific geothermal systems (fig. 3). Through the cooperation of Federal and State agencies, a significant information base on Alaska's geothermal resource has been developed and is now available to the public.

The DOE closed its regional office in Anchorage in 1985. Requests for information about DOE Alaskan activities should be addressed to the office listed below.

Contacts For Further Information

Bureau of Land Management
Michael Penfold, State Director
Federal Building
701 C Street, Box 13
Anchorage, AK 99513

Fish and Wildlife Service
Walter O. Stieglitz, Regional Director
1011 East Tudor Road
Anchorage, AK 99503-6119

Minerals Management Service
Noreen Clough
Office of Program Review
Main Interior Building
Room 4220, MS 622
18th and C Streets NW
Washington, DC 20240

National Park Service
Boyd Evison, Regional Director
Alaska Regional Office
2525 Gambell Street
Anchorage, AK 99503-2892

U.S. Bureau of Mines
Donald P. Blasko, Chief
Alaska Field Operations
Center - Suite 101
201 East Ninth Avenue,
Anchorage, AK 99501

U.S. Geological Survey
Donald Grybeck, Chief
Branch of Alaskan Geology
4200 University Drive
Anchorage, AK 99508-4667

U.S. Forest Service
Michael Barton, Regional Forester,
Alaska Region
P.O. Box 1628
Juneau, AK 99802

Department of Energy

Hydrocarbon resources
Joseph Lagler
Morgantown Energy
Technology Center
P.O. Box 880
Collins Ferry Road
Morgantown, WV 26507

Geothermal resources
Marshall Reed
Geothermal Technology Div.
U.S. Department of Energy,
CE-342
Washington, DC 20585

ENERGY RESOURCES

Oil and Gas Resources

OVERVIEW OF PRODUCTION AND PRICES

In 1987, as in the previous several years, oil and gas were the most valuable commodities produced in Alaska. Alaska's two oil-producing areas, the Arctic North Slope and the Cook Inlet (fig. 5), provided a total of 716.0 million barrels (1 barrel = 42 gallons) of oil, 186.4 billion cubic feet of dry natural gas, and 1.52 billion cubic feet of casinghead

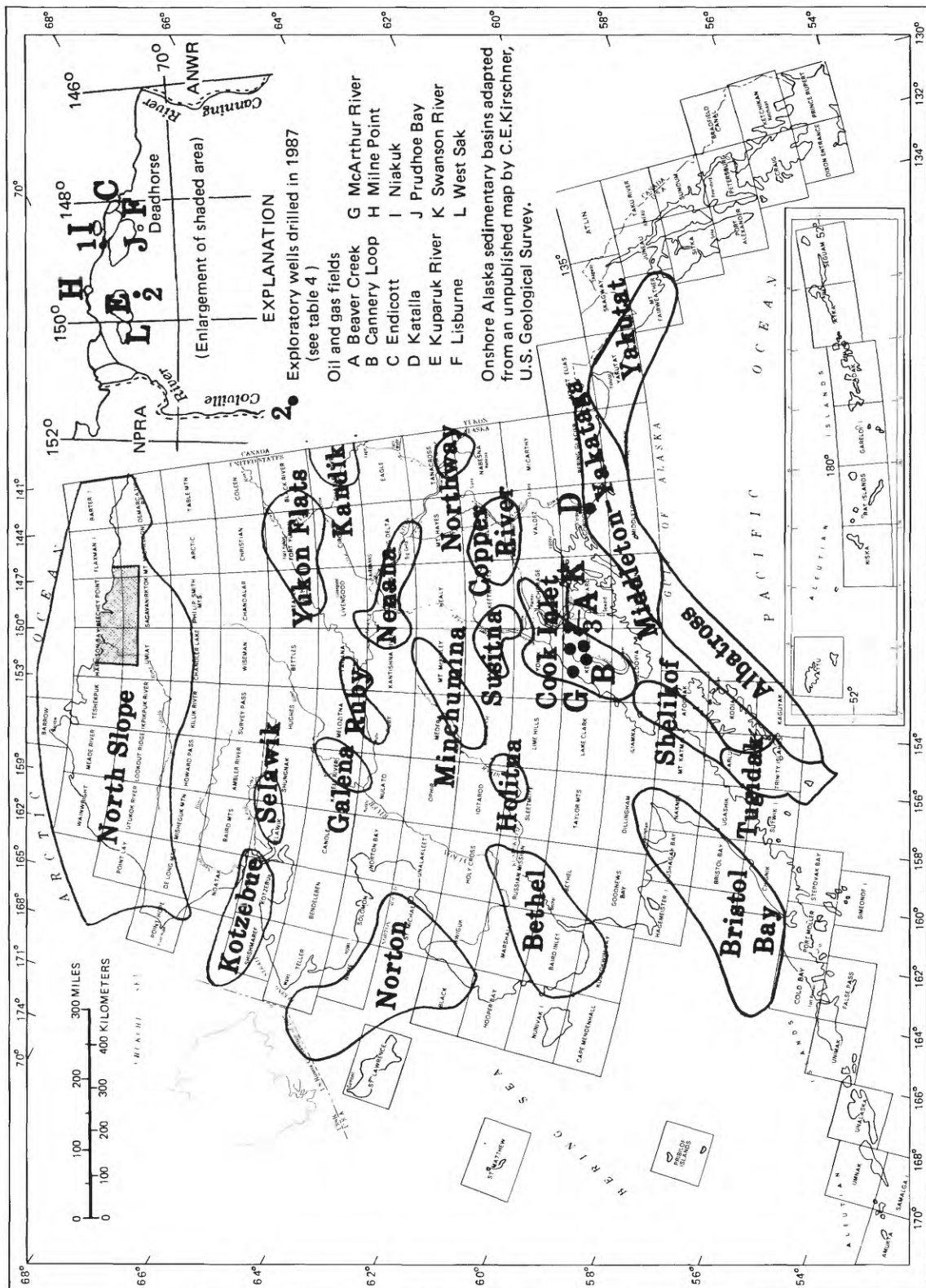


Figure 5. Locations of exploratory wells drilled in 1987, oil and gas fields, and possible petroleum-bearing onshore sedimentary basins.

gas in 1987. This production represents an increase over 1986 of about 5 percent for oil and 2.6 percent for gas (Alaska Oil and Gas Conservation Commission, 1988). Production increases from the State of Alaska's North Slope leases offset production declines from the Cook Inlet. Alaskan oil production increased by about 90,000 barrels per day (bbl/d) in 1987, mainly the result of production increases from the Kuparuk River field and the Endicott field (Petroleum Information, Alaska Report, v. 33, no. 40, Oct. 7, 1987). The daily rate of oil production increases from the entire State of Alaska at the end of 1987 amounted to 1,950,322 million barrels (Petroleum Information, Executive Summary, Dec. 1987), or about 23 percent of the United States' daily production. In 1987, unofficial production data indicate that Alaska, with 2.0 to 2.1 million barrels of oil per day, has passed Texas, with 1.96 million barrels per day, in daily oil production (Anchorage Daily News, Jan. 14, 1988).

A decline in the world price of oil that began in late 1985 continued into 1986 but improved in 1987 (fig. 6). The daily price between December 1985 and July 1986 declined from about \$27 per barrel to \$9 per barrel for Standard Oil Co.'s Alaska North Slope contract price delivered to the west coast (Petroleum Information, Alaska Report, v. 32, no. 27, July 9, 1986). By the end of 1986 the price of North Slope crude delivered to the west coast of the United States had increased to \$14.25 per barrel (table 1). For 1987, the price of North Slope crude oil delivered to the west coast rose to a high of \$18.75 per barrel in August and then declined to \$15.75 per barrel by the end of the year. The State of Alaska is especially vulnerable to crude oil prices, because 85 percent of the State's current revenue is derived from royal-

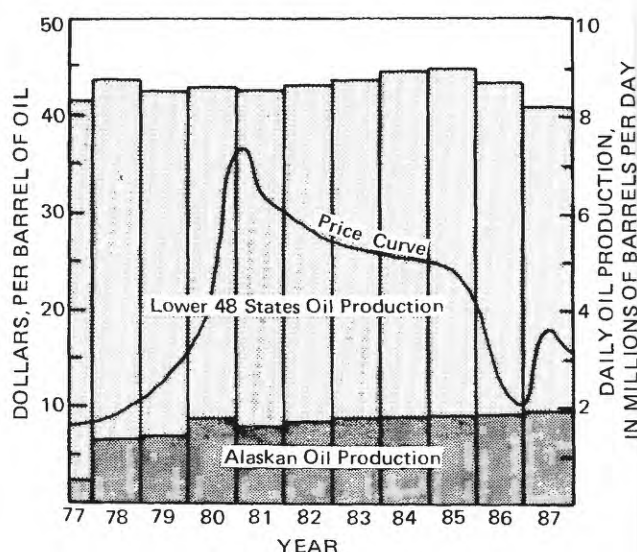


Figure 6. Average annual U.S. oil production and average annual price of oil for the years 1977 to 1987. Data from Oil and Gas Journal, Jan. 26, 1987, Alaska State Oil and Gas Commission, 1985, and table 1.

Table 1. Fluctuation of the price of Alaska North Slope crude oil

[Data from the Petroleum Information Alaska Reports; Standard Oil Company's Alaska North Slope contract; crude oil price represents 95 percent of production; WC, delivered to West Coast; GC, delivered to Gulf of Mexico]

Date	Cost per barrel	
	WC	GC
12/31/86	\$14.25	\$15.25
02/01/87	15.25	16.25
04/01/87	16.75	17.75
06/01/87	17.25	18.25
07/01/87	17.75	18.75
08/01/87	18.75	19.75
09/01/87	18.00	19.00
10/01/87	17.25	18.25
11/01/87	17.75	18.75
11/15/87	17.25	18.25
12/01/87	16.75	17.75
12/15/87	15.75	16.75

ties and taxes paid on State-owned oil and gas leases (Alaska Division of Geological and Geophysical Surveys, 1986). The sensitivity of oil prices on the exploration for and production of oil fields was reflected in the curtailment of many industry activities. For example, the Milne Point oil field, the third field to produce on the North Slope, was still shutdown by the end of the year. However, Conoco has shown signs of resuming development work (Anchorage Daily News, Jan. 15, 1988). The major operators maintained reduced capital budgets, which affect all aspects of the business and have a trickle-down effect on other industries in the State. ARCO Oil and Gas, Standard Oil Co., and Chevron Corp. all had lower net incomes for 1987, attributed mainly to the lower crude oil prices.

DEVELOPMENT AND TECHNOLOGY

Despite the depressed condition of the oil industry, development of the present fields is proceeding as scheduled or ahead of schedule. Contributing to the ongoing development on the North Slope, the 1987 sealift of 5 barges was the fourth smallest of its kind since 1968, but included the largest modules, some of which are 11 stories high, ever shipped to the North Slope (table 2). The modules on four of the barges are for the Endicott field and include power generation units, compressor units, waste heat generation facilities, waste treatment facilities, water filtration and purification equipment, and other facilities. This may be the last sealift to the North Slope in the foreseeable future (Anchorage Times, July 25, 1987). The Endicott field (fig. 5) started to produce oil on October 3, 1987, 2½ months ahead of schedule and under budget by over one billion dollars, at a rate of 40,000 bbl/d (Anchorage Times, Oct. 6,

Table 2. Twenty years of sealifts to the North Slope of Alaska
[Data provided by Standard Alaska Production Co. in Alaska Journal of Commerce and Pacific Rim Reporter, week of August 10, 1978, p. 2]

Year	Number	Tonnage	Year	Number	Tonnage
1968	2	5,529	1978	10	39,558
1969	31	75,000	1979	2	7,984
1970	36	187,000	1980	10	44,091
1971	6	16,022	1981	14	55,446
1972	2	6,192	1982	15	69,600
1973	8	21,000	1983	26	96,500
1974	16	65,650	1984	11	30,089
1975	47	154,420	1985	13	48,159
1976	21	64,324	1986	27	103,033
1977	7	45,790	1987	5	25,443
Total-----				309	1,160,830

1987). This field is estimated to contain 350 to 375 million barrels of recoverable oil and 1.5 trillion cubic feet of natural gas. The daily production rate soon will be increased to 100,000 barrels a day, and eventually to 360,000 barrels a day (Alaska Journal of Commerce and Pacific Rim Reporter, Oct. 12, 1987). Meanwhile, in the Cook Inlet, the Swanson River oil field (fig. 5) celebrated its 30th birthday on July 23, 1987. To that date, 152 million barrels of oil had been extracted from this first oil field in Alaska. The field discovery in 1957 started the exploration effort that eventually found more than 20 oil and gas fields in the Cook Inlet (Anchorage Times, July 26, 1987). Unocal was given the approval by the Alaska Oil and Gas Conservation Commission to use waterflooding in the McArthur River West Forelands oil pool (fig. 5). The enhanced oil recovery project includes 8 to 10 injection wells and could increase field production by 4.3 million barrels (Petroleum Information, Alaska Report, v. 33, no. 7, Feb. 18, 1987). The Cannery Loop gas field (fig. 5) entered a new stage of exploration and development with the drilling of the No. 4 well which will test the deeper horizons (Hemlock Conglomerate and Tyonek Formation) for oil (Anchorage Daily News, May 5, 1987). If the \$30 million well is successful, about 50 Kenai residents stand to collect royalties on their mineral rights.

New technologies were tested on the North Slope during 1986 and put to work in 1987. Standard Alaska Production drilled three horizontal development wells in the Prudhoe Bay field (fig. 5). The advantage of a horizontal well as compared to a conventional well is that more area in the productive zone is exposed to the well bore, thereby allowing more oil to be produced (Oil and Gas Journal, Feb. 16, 1986). Horizontally drilled wells also have the potential to produce from areas of a reservoir that would not be practical to produce using conventional wells, such as a very thin, but laterally extensive, portion of a reservoir. Other technologies to enhance production include natural gas and

Table 3. State of Alaska onshore oil and gas lease sales, 1987
[Data from Petroleum Information's Alaska Reports; areas shown in fig. 7; all sales were conducted by the State of Alaska, Department of Natural Resources, Division of Oil and Gas]

Sale name-----	Prudhoe Bay Uplands	Camden Bay
Sale number-----	5150	
Sale date (month/day/year):	01/27/87	06/30/87
Cash bonus bid with fixed royalty (in percent) of:	12.5	16.67
Total number of bids received:	32	157
Tracts offered:	119	35
Acreage offered:	592,142	118,147
Tracts sold:	26	35
Acreage sold:	100,632	118,147
Total high bonus bids:	\$289,625	\$6,621,723
Total exposure (sum of all bids):	\$336,254	\$11,481,371
Average high bonus bid per acre:	\$2.88	\$56.05
Highest bid for a tract:	\$18,144	\$1,122,000
Highest per-acre bid:	\$4.30	\$423.39

seawater injection. This new technology will extend the time, by at least a year, the Prudhoe Bay field will produce at a rate of 1.5 million barrels a day. Production with current methods will fall off in 1990 (Anchorage Daily News, Jan. 29, 1988).

Items that will affect the future of Alaska oil production are as follows. A new pipeline, the All-American Pipeline, which stretches from California to west Texas and will eventually be extended to the Houston area, is presently carrying 35,000 bbl/d of North Slope crude. Eventually, throughput could jump to 80,000 barrels of oil a day (Anchorage Daily News, Dec. 5, 1987). Standard Alaska Production Co. will begin to develop the Eileen area of the Prudhoe Bay field at the extreme west end of the field. This is a development that was delayed two years because of low oil prices (Anchorage Times, Dec. 16, 1987). The discovery in April 1985 of the Niakuk field, which contains 150 million barrels of in-place oil of which 58 million barrels are recoverable, set the stage for another offshore development project that could start as early as 1989, if all permits are received and all other technical, environmental, and managerial plans work out (Anchorage Daily News, Dec. 18, 1987).

STATE ACTIVITY AND LEASE SALES

During 1987, State agencies conducted two onshore competitive oil and gas lease sales (table 3), monitored and supervised lease development, collected rent on leases and royalties on production, and conducted numerous geologic and geophysical studies relating to oil and gas resource evaluation and land classification. These studies are only briefly reported in this circular; for Federal studies, the reader is directed to the most recent edition of the circular

Table 4. Onshore Alaska exploratory test wells, 1987

[Areas shown in figure 5. Test, testing for oil or gas; tight, tight hole; UM, Umiat Meridian; SM, Seward Meridian; P&A, Plugged and abandoned]

Well No.	Company	Well name	API No.	Location (township-range-section)	Total depth (in feet)	Date completed	Remarks
1	Vaughn Petroleum	Kup delta 1	50-029-21685	12N-13E-17 UM	10,770	02/07/87	P&A
2	ARCO Alaska	Kuparuk River Unit WT-3	50-029-21703	10N-10E-32 UM	4,000	04/04/87	Tight
3	UNOCAL	Cannery Loop Unit 4	50-133-20387	5N-11W-04 SM	16,500	--	Test

entitled "Geologic studies in Alaska by the U.S. Geological Survey during 1987" (Galloway and Hamilton, 1988), and for State activities, the State of Alaska quarterly report, "Alaska Mines and Geology." During 1986, the Alaska Department of Natural Resources published Information Circular 31, "Oil-And-Gas Resources of Alaska" (Alaska Division of Geological and Geophysical Surveys, 1986), which presents an overview of the history of exploration and development, current prospects, resource estimates, and the State's leasing program.

At the competitive State lease sales, a total of \$6.9 million was paid in high bids to acquire about 219,000 acres for future exploration. At least four oil companies and several independent investors participated in each of the sales. Information about the lease sales is summarized in table 3, and the lease sale areas are shown in figure 7. The terms of the leases, which in 1987 are all on State lands, can be obtained from the Lease Administration Office, Alaska Department of Natural Resources, 555 Cordova Street, Anchorage, AK 99501. For further information about State petroleum-related activities, readers should contact the Alaska Division of Oil and Gas, 3601 C St., Anchorage, AK 99503, or obtain Information Circular 31 from the Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys.

INDUSTRY ACTIVITY

Industry activity for onshore Alaska in 1987 included further delineation of a new oil field and startup of oil production from another field, both of which are located on the North Slope, as well as geophysical and geological surveys and drilling of three exploratory wells (table 4, fig. 5) and about 200 development wells. Development drilling was concentrated primarily on the North Slope in four producing and several developing fields. Two of the exploratory wells are located on the North Slope and the other in the Cook Inlet area. Little information has been released to the public, but some information is made available through private subscription services, such as Petroleum Information's weekly

Alaska Report. In 1985-1986, Chevron USA Inc., Standard Oil Co., and BP Alaska Exploration Co. drilled the first exploratory well on Native lands in the Arctic National Wildlife Refuge. There has been great interest in waiting for the results of the KIC (Kaktovik Inupiat Corp.) No. 1 well because the Arctic National Wildlife Refuge is considered to contain the most promising accumulation of hydrocarbons remaining on the North Slope.

The Prudhoe Bay field (fig. 5), the world's 19th largest producer (Tiratsoo, 1984), and largest field in the United States, produces at a rate of almost 1.6 million bbl/d. A seawater treatment plant, installed in 1984, injects about 1.4 million bbl/d of water into the producing reservoir to increase the amount of oil recovered (Petroleum Information, Alaska Report, Feb. 1987). January 1987 marks the date that the full scale enhanced oil recovery project started. In March 1987, the Prudhoe Bay oil field produced its five billionth barrel of oil (table 5), surpassing the East Texas field, which has produced 4.9 billion barrels (Petroleum Information, Alaska Report, v. 33, no. 12, Mar. 25, 1987). This represents the approximate halfway point for the Prudhoe Bay field, which has accounted for about 17 percent of the Nation's output since 1977 (Pacific Oil World, Jan. 1987). June 20, 1987, marks the 10th anniversary of the first shipment of oil through the Trans-Alaska Pipeline System (TAPS) from the North Slope to the ice-free port of Valdez, an 800-mile journey (Petroleum Information, Alaska Report, v. 33, no. 24, June 17, 1987).

The second largest oil field in the U.S., the Kuparuk River field (table 5), produced about 99.6 million barrels of oil in 1987 or an average of about 273,000 bbl/d. Beginning in December 1986, a new production facility was brought online to boost daily output by about 16 percent, from 258,000 bbl/d in 1986 to 300,000 bbl/d in 1987.

The Milne Point field (fig. 5), the third field to produce oil on the North Slope, has suspended production only one year after beginning operation. Conoco Inc. and partners (Champlin Petroleum Co., Cities Service Oil and Gas Co., Chevron USA, Inc., and Reading and Bates Petroleum Co.) cited several factors for the shutdown, including the

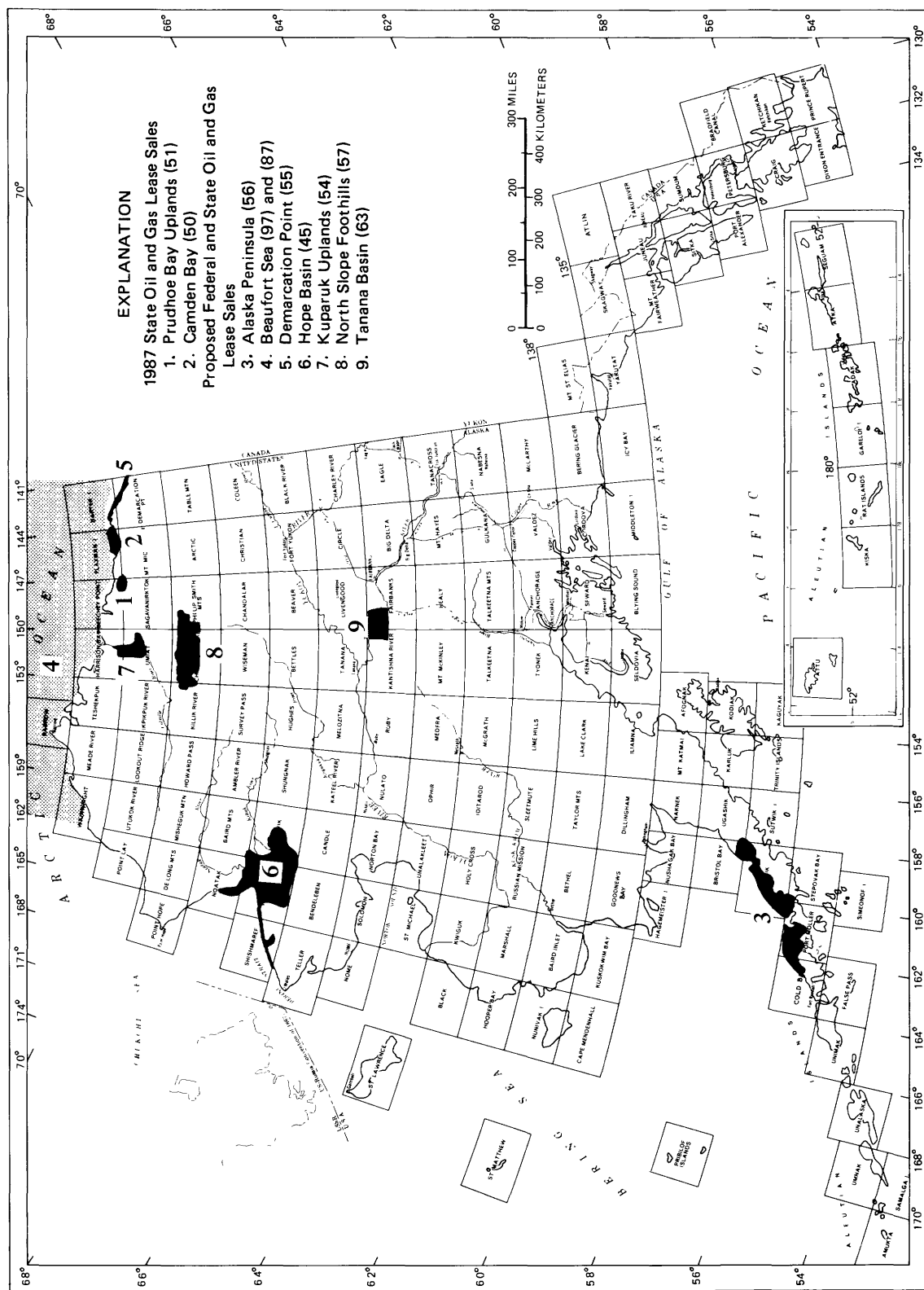


Figure 7. Areas of oil and gas lease sales.

Table 5. Alaskan oil fields with original reserves exceeding 50 million barrels

[From Oil and Gas Journal, Jan. 25, 1988, p. 60]

Field	Discovery date	1987 production (x1000 bbl)	Cumulative production on 01-01-88 (x1000 bbl)	Estimated remaining reserves (x1000 bbl)	Estimated number of wells
North Slope					
Endicott	1978	7,000	7,000	368,000	20
Kuparuk River	1969	99,595	397,913	1,107,000	332
Lisburne	1967	16,341	21,919	190,289	42
Milne Point ¹	1969	0	5,453	95,547	19
Niakuk ²	1985	0	0	58,000	--
Prudhoe Bay	1967	³ 571,000	45,506,886	4,110,000	665
Cook Inlet					
Granite Point	1965	2,685	106,841	19,000	28
McArthur River	1965	7,300	521,689	42,000	75
Middle Ground Shoal	1962	2,800	153,102	8,000	41
Swanson River	1957	2,012	207,307	8,000	27

¹Under "warm" shut-in for 1987, before it could attain peak flow of 30,000 bbl/d (Oil and Gas Journal, v. 85, no. 4, p. 68).²Anchorage Daily News, Dec. 16, 1987; Petroleum Information's Alaska Report, v. 33, no. 51.³Includes about 26.28 million barrels of condensate.⁴Includes about 108 million barrels of condensate.

depressed price of crude oil and equipment problems that reduced daily output in half (from 20,000 bbl/d to 10,000 bbl/d). The Milne Point field has estimated remaining recoverable reserves of about 90 million barrels (table 5) with plans for the field to produce 30,000 bbl/d. Conoco is keeping the facility operational should there be a dramatic increase in the price of oil (Petroleum Information, Alaska Report, v. 32, no. 49, Dec. 10, 1986). By the end of 1987, Conoco was considering resuming development work, probably by the end of 1988.

The Lisburne field (fig. 5) became the fourth field to begin production on the North Slope on Dec. 15, 1986. ARCO Alaska Inc. and its partners, Exxon Co. USA and Standard Alaska Production Co., plan to produce 40–50,000 bbl/d from the field, which underlies the northeastern part of the Prudhoe Bay field. The Lisburne production facility has a capacity to produce 100,000 bbl/d from the 190 million barrels of estimated remaining recoverable reserves (table 5). To the end of 1987, the Lisburne field produced 21 million barrels of oil (table 5). The Endicott field, with reserves from 350–375 million barrels and 800 billion cubic feet of gas, began production in late 1987 and has produced 7 million barrels of oil (table 5). Standard Alaska Production Co. is using two island bases for the development of the field. Oil from the Endicott field is being transported by pipeline

to the Trans-Alaska Pipeline System's Pump Station No. 1 at Prudhoe Bay.

In September, TAPS was shut down for 5¹/₅ days to replace 223 feet of 48-inch-diameter pipe just north of Atigun Pass near Mile Post 166. The repair was necessary for two reasons: first, to repair a buckle in the pipe located about 80 feet south of a place where the pipeline sustained a hairline crack in 1979; and second, to remove two bends put in the pipeline during the original construction. These bends make it difficult for the pigs to get through the pipeline (a "pig" is a device sent down a pipeline to clear out or alert the pipeline operators of any obstruction that may be in the way of oil flow (Anchorage Times, Sept. 17, 1987).

Standard Alaska Production Co. submitted plans in June to the Minerals Management Service (MMS) for the "permanent reclamation and abandonment" of Mukluk Island starting in July. Mukluk Island, a 2.5-acre man-made gravel pad, was the exploratory well site drilled in 1983 at a cost of over \$1.5 billion to test a geologic structure in the Beaufort Sea just off the Colville delta. According to the plan, the company will remove all protective fabric and gravel bags to lower the island's surface 15–25 feet below sea level so that natural forces can easily remove the remaining part of the island (Petroleum Information, Alaska Report, v. 33, no. 24, June 17, 1987). The cost to Standard will be more than \$2

million and, weather permitting, will take 3 weeks. The well site will be monitored for 5 years to be sure the abandonment caused no adverse effect on the environment (Anchorage Daily News, July 31, 1987).

ARCO Alaska, Inc. has concluded a two-year pilot project to determine the feasibility of producing the estimated 20 billion barrel heavy-oil accumulation at the West Sak field (fig. 5) on the North Slope. The reservoir covers about 250 mi² and is located at depths between 3,000 and 4,000 ft. The project involved injecting hot water into the reservoir in hopes of reducing the viscosity of the oil, thereby allowing the oil to flow more easily through the reservoir (Anchorage Daily News, Jan. 22, 1987).

The Katalla oil field located in the Gulf of Alaska (fig. 5), abandoned since the 1930's, has been reactivated. Alaska Crude Corporation (ACC) resumed drilling the KS#1 well in 1986. However, by November, ACC suspended operations at the Katalla River location, where the company had planned to drill 10 shallow production wells to recover an estimated 3 million bbl of oil (Petroleum Information, Alaska Report, v. 31, no. 52, Dec. 31, 1985). There is no change in the status of the Katalla oil field to the end of 1987.

ACTIVITY BY FEDERAL AGENCIES

U.S. Geological Survey

The North Slope continues to be the focus of most USGS studies related to onshore oil and gas resources. Many of the studies are part of the Evolution of Sedimentary Basins Program, the Gas-Hydrate Program, or the Ellesmerian Petroleum System Project. South of the Brooks Range, petroleum studies are supported by the Alaska Mineral Resource Assessment Program (AMRAP). The paragraphs below summarize recent activities, and current projects are listed in table 6. Selected pertinent papers are listed in appendix 1 along with papers published by the U.S. Geological Survey and the Department of Energy.

Many of the numerous talks and posters concerning geologic aspects of Alaskan oil and gas resources that were presented at the regional meeting of the American Association of Petroleum Geologists (AAPG) and Society of Economic Paleontologists and Mineralogists (SEPM) held in Anchorage in 1985 were published in 1987 (Tailleur and Weimer, 1987). More than one-hundred papers and abstracts are included in this two-volume series. The annual meeting of the AAPG and SEPM held in Los Angeles in June 1987 had several talks and posters reviewing studies in Alaska by the Geological Survey (for list of abstracts see AAPG Bulletin, v. 71, no. 5, 1987). In mid-November, a seminar entitled "Petroleum Geology of the 1002 Area of the Coastal Plain of the ANWR" was held at the Sheraton Hotel in Anchorage. The U.S. Geological Survey presented selected papers from Bulletin 1778, edited by K.J. Bird and L.B. Magoon.

Table 6. Areal energy resource assessments by the Branch of Petroleum Geology, USGS, during 1987 [Project chiefs shown in parentheses]

STUDIES SUPPORTED BY AMRAP	
Interior Basins Project:	
(1)	Petroleum potential of the Yukon-Kandik basin (H.E. Cook)
(2)	Geologic framework and petroleum potential of the Nenana basin (R.G. Stanley)
(3)	Petroleum geology of the Alaska Peninsula (L.B. Magoon)
Central Arctic Management Area:	
(4)	Petroleum Geochemistry of the Killik River and the Chandler Lake quadrangles (L.B. Magoon)
OTHER CURRENT STUDIES IN ALASKA BY THE USGS BRANCHES OF PETROLEUM GEOLOGY AND SEDIMENTARY PROCESSES	
(1)	Oil and gas potential of the interior basins (L.B. Magoon)
(2)	Ellesmerian petroleum system, North Slope of Alaska (K.J. Bird)
(3)	North Slope of Alaska basin study (K.J. Bird)
(4)	North Slope of Alaska gas-hydrate evaluation study (T.S. Collett)
(5)	Petroleum potential of the 1002 area of the Arctic National Wildlife Refuge (ANWR) (K.J. Bird)
(6)	Deep-source gas potential in accretionary belts of the Eastern Brooks Range (D.G. Howell)

National Petroleum Reserve in Alaska

The operational phase of the Federal petroleum exploration program in the National Petroleum Reserve in Alaska (NPRA) was completed in 1981. A nontechnical report (Gryc, 1985) describes this program. Meanwhile, more than 30 technical papers by USGS scientists are in the final stages of completion for publication as USGS Professional Paper 1399 (Gryc, available in early 1989). Topics to be included are stratigraphy, sedimentation, seismic stratigraphy, petrography, paleontology, biostratigraphy, petroleum source-rock geochemistry, structural geology, direct hydrocarbon detection by aeromagnetic and helium methods, assessment results, and exploration history. Most data from the 1974-81 exploration program, as well as numerous pertinent contractor reports, are available to the public through the National Geophysical and Solar-Terrestrial Data Center, Boulder, CO 80303. Their catalog itemizes information about 38 wells, 14,770 line-miles of reflection seismic surveys, 52,000 gravity measurements, and numerous reports about geology, geophysics, the environment, construction, and logistics.

Gas Hydrates

The North Slope natural gas-hydrate evaluation project, funded by the Department of Energy, continued to be very

active through 1987. Study of the physical properties controlling in-situ natural gas-hydrate stability dominated the research efforts. Topics of talks and publications during 1987 include: evidence for naturally occurring gas hydrate (Collett and Kvenvolden, 1987); the effect of freezing-point depression on ice-bearing permafrost (Collett and others, 1986); gas-hydrate stability (Collett, 1987a; Kamath and others, 1987); geochemical and geologic control on gas-hydrate stability (Collett, 1987b; Collett and others, 1987); and a regional correlation section (Molenaar and others, 1987). Geologic and geochemical samples collected from an ARCO Alaska Co. production well in the Kuparuk River field (fig. 5) are being studied to determine the compositions of natural gases in the near surface sediments (0–1,000 m) of the North Slope and to characterize the potential gas-hydrate reservoirs.

Petroleum Potential of the Eastern Brooks Range

In another DOE-funded study, USGS and university scientists completed a study in the eastern Brooks Range and Charlie River-Eagle areas (nos. 7, 8, fig. 8). The goal of this study is to project the known structural and stratigraphic relations into the Yukon Flats sedimentary basin and evaluate the potential of that region for generating and trapping deep gas resources. This study is part of a larger effort to evaluate the potential for the occurrence of deeply buried petroleum resources along ancient convergent continental margins where obductive processes have been dominant. Field mapping and paleontologic and geochemical studies have shown new age and structural relations in these geologically complex areas in which several accreted terranes are now recognized. Three talks were presented at the Los Angeles 1987 AAPG convention (Jones and others, 1987; Howell and others, 1987; Wiley and others, 1987). The final report for this study was submitted to DOE in December 1987.

Interior Basins of Alaska

During 1987, USGS scientists continued their work summarizing the geology and evaluating the petroleum potential of the interior basins of Alaska (those south of the North Slope and generally north of Cook Inlet as shown on fig. 5). A 4-week field program studied in detail the facies relations, sedimentology, and biostratigraphy of the Tertiary fluvial and lacustrine deposits in the Nenana basin. Using Rock-Eval pyrolysis, vitrinite reflectance, and kerogen tests, the petroleum source potential of the coals and mudrocks associated with the Tertiary deposits was determined. Two articles in USGS Circular 998 (Stanley, 1987a, b) show results of the Nenana basin studies. A poster session presented at the 1987 National AAPG convention in Los Angeles by Stanley (1987c) summarizes the reconnaissance study of the Cantwell Formation (Paleocene). A poster session presented at the AAPG convention in Los Angeles reviews the find-

ings of the reconnaissance work (Magoon, 1987; also see Cook and others, 1987).

Bureau of Land Management

In establishing and implementing an oil and gas leasing program as required by Section 1008 of ANILCA, the BLM has made land available for noncompetitive oil and gas leasing in three areas south of lat 68° N. (fig. 8). The Minchumina area was opened in 1981, the Denali-Tielke area in 1982, and the Seward Peninsula in 1983. As of December 31, 1987, the BLM had issued approximately 258 leases on 64,513 acres in the Minchumina area, 5,024 leases on 812,684 acres in the Denali-Tielke area, and 1,900 leases on 1,060,346 acres in the Seward Peninsula. A total of 7,156 acres was leased in these areas during 1987. The locations of the general lease areas are shown in figure 8. Three Favorable Petroleum Geological Provinces (FPGP) were identified by the Secretary of the Interior under the authority of Section 1008 of ANILCA; however, no competitive oil and gas lease sales were held as a result of a FPGP determination. The Federal Onshore Oil and Gas Leasing Reform Act of 1987 amended Section 1008 to eliminate FPGP, thus placing Alaska under the same competitive leasing system as the rest of the country. The three FPGP areas were the Cook Inlet, Gulf of Alaska, and Cape Lisburne.

The National Wildlife Federation v. Burford et al. lawsuit, concerning land withdrawals and classifications, specifically affects areas of the Seward Peninsula opened to oil and gas leasing and the mining laws under the authority of Section 204(a) of the Federal Land Policy and Management Act, by Public Orders 6477 and 6559 of October 5, 1983, and August 9, 1984, respectively. An injunction effective February 14, 1986: (1) enjoins the Department of the Interior from revoking withdrawal or termination classifications in existence as of January 1, 1981; (2) enjoins the Department of the Interior from taking actions inconsistent with specific terms of the above withdrawals or classifications; (3) suspends all revocations of withdrawals and terminations of classifications completed after January 1, 1981; (4) allows the Department of the Interior to accept filings required by law; and (5) exempts Alaska from the order where lands affected are for Native or State conveyances. Essentially, for the Seward Peninsula area, any pending offers on oil and gas leases will be suspended, and no new offers will be considered.

A fifth lease sale in the NPRA (fig. 8) was postponed again in 1987, owing to low demand for NPRA leases and low world crude-oil prices. Since leasing began in 1982, 56 leases covering approximately 1,350,000 acres have been issued in the NPRA; 10 leases were relinquished in 1987, and 24 leases remain in effect.

There were no new exploratory wells drilled on BLM-administered land during 1987.

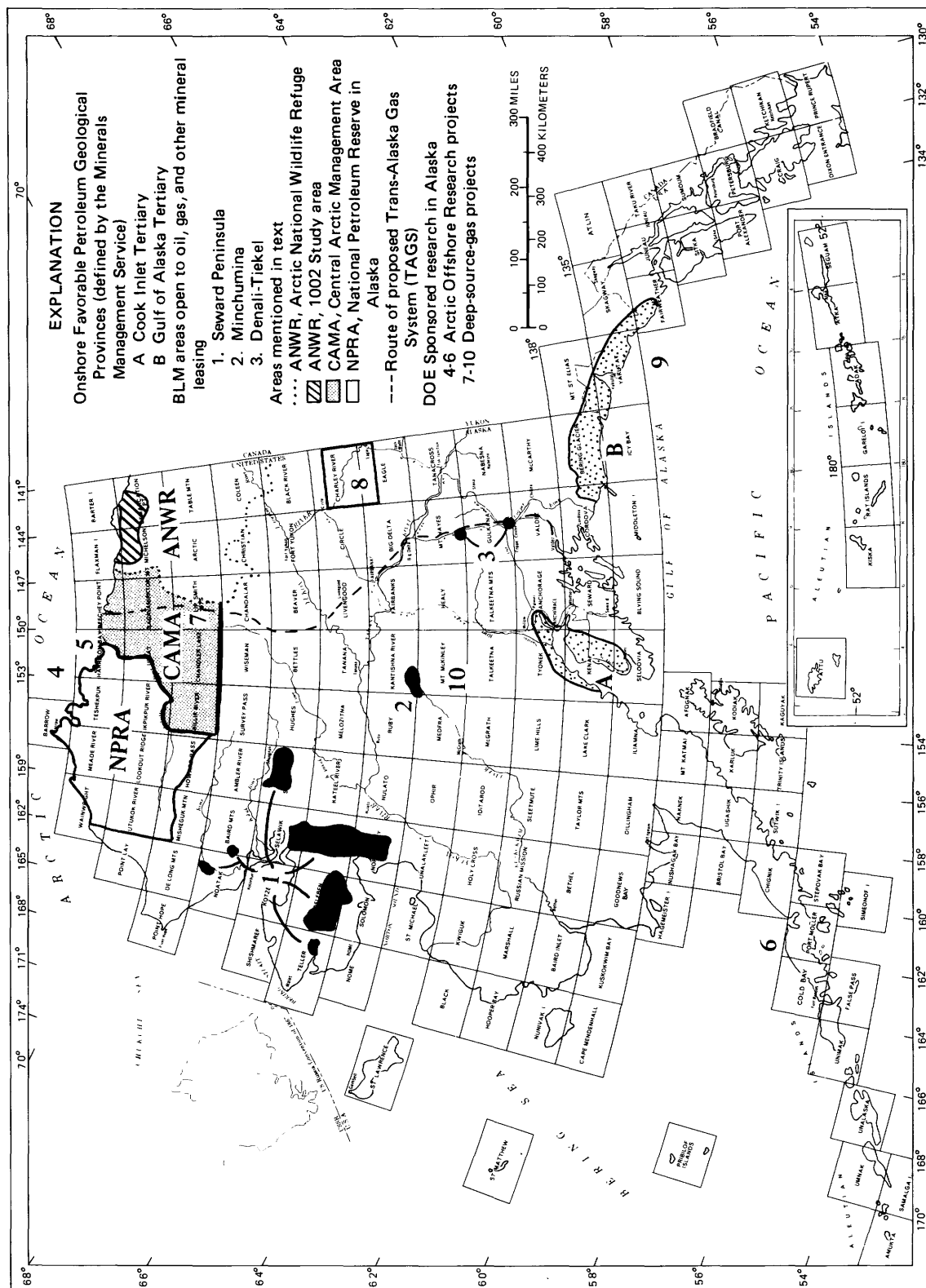


Figure 8. Onshore Favorable Petroleum Geological Provinces, land units referred to in text, and locations of Department of Energy-funded research during 1987.

By January 1988, the BLM provided the FWS with oil and gas resource assessments for three national wildlife refuges: Yukon Delta, Nowitna, and Selawik (fig. 3). The FWS will use these assessments to help determine whether oil and gas leasing and development is compatible with the intent of these refuges.

The BLM continued preparation of a resource-management plan during 1987 for the "utility corridor" along the Trans-Alaska Pipeline and adjacent BLM-administered lands north of the Yukon River.

The annual report of the BLM's Branch of Pipeline Monitoring is available through its Public Affairs Office in the Federal Building in Anchorage. This branch, part of the Division of Mineral Resources, assures that the terms and conditions of Alyeska Pipeline Service Co.'s pipeline right-of-way are met.

The BLM's involvement with the Northwest Alaska Pipeline Co.'s proposed Alaska Natural Gas Transport System (ANGTS) remains at a low level. During 1987, the BLM published the draft EIS for the Yukon Pacific Corporation's right-of-way application for its proposed Trans-Alaska Gas System (TAGS) (fig. 8) and the draft grant of right-of-way, and requested public comments.

Fish and Wildlife Service

The primary efforts of the FWS in Alaska are to protect and conserve fish and wildlife, and their habitats, and to administer 16 national wildlife refuges (fig. 3). The FWS also cooperates with other Federal and State agencies in similar efforts on behalf of wildlife throughout Alaska. Any oil- or gas-related activities in refuges are subject to FWS restrictions and protective stipulations.

Kenai National Wildlife Refuge

The Kenai National Wildlife Refuge is the only refuge in Alaska from which oil and gas have been produced. In 1987, 29 wells continued production from the Swanson River field (fig. 5), with a production of about 6,100 bbl/d. A workover rig was used in the field early in the year, continuing to correct problems at several of the wells, but has now been stacked. Maximum production of under 40,000 MCF/d from 4 gas wells and about 450 bbl/d from 2 oil wells is being produced in the Beaver Creek field (fig. 5).

In 1985, an agreement was reached among the Bureau of Land Management, the Alaska State Department of Environmental Conservation, the Fish and Wildlife Service, and Chevron USA, Inc., for the cleanup of polychlorinated-biphenyl (PCB)-contaminated materials inadvertently used for dust control on some roads within the oil fields. That agreement and the established cleanup levels have been accepted in a memorandum of understanding with ARCO Alaska, Inc. the unit operator, as of October 1, 1986. As of

this date, all of the contaminated soils on roads have been excavated and stockpiled in lined pits awaiting processing; most of the contaminants around the compressor plant complex have also been removed, with this work to be completed in the summer of 1988. Under current plans, the processing of the contaminated materials will begin during the spring of 1988.

Activities under Section 1008 of ANILCA

Section 1008 of ANILCA provides for oil and gas studies on refuges in Alaska to provide information for use in future land-management decisions. In 1987, special use permits were issued for surface geologic work in the Alaska Maritime, Arctic, and Alaska Peninsula National Wildlife Refuges. Exxon, Inc. has received a permit for seismic exploration within the Yukon Flats National Wildlife Refuge (fig. 9) for the early months of 1988. Special use permits include numerous stipulations for ensuring that permitted activities are environmentally sound and compatible with refuge purposes, and are designed for the specific locale and activities of the proposal. Bonds of at least \$10,000 must be posted before any company can undertake such work in Alaska refuges. Copies of data resulting from such exploration must be submitted to the FWS; they remain confidential in storage with the BLM.

Section 1008 of ANILCA also calls for establishing a program for oil and gas leasing on Federal lands south of lat 68° N., pursuant to the Mineral Leasing Act of 1920 as amended. This program does not apply to those refuge lands where the Secretary of the Interior determines, after consideration of the national interest, that oil and gas exploration or development would be incompatible with the purposes of the refuge. Section 304(g) of ANILCA cites a comprehensive conservation planning process as the means for identifying parts of refuges where leasing or related activities may be compatible.

Final plans were issued in 1987 for the Innoko, Kanuti, Kodiak, Koyukuk, Nowitna, Selawik, Tetlin, Yukon Delta, and Yukon Flats National Wildlife Refuges (U.S. Fish and Wildlife Service, 1987a, b, c, d, e, f, g, h, and i). Draft plans were released for the Alaska Maritime and Arctic National Wildlife Refuges in early 1988 (U.S. Fish and Wildlife Service, 1988a, b). These plans will be finalized in 1988, completing the comprehensive conservation planning process mandated by ANILCA. (See fig. 3 for National Wildlife Refuge locations.)

Refuge lands leased by the BLM will be competitively leased if the land is in a Favorable Petroleum Geologic Province (as identified by the Minerals Management Service) (fig. 8), or noncompetitively leased if not within such a province. All leasing, exploration, and production would be subject to permits and stipulations designed to protect fish, wildlife, and subsistence activities.

Mineral Activity Impact Assessment

FWS mineral-related activity includes making recommendations for mitigating adverse impacts on fish and wildlife, and their habitats. To this end, the FWS reviews U.S. Army Corps of Engineers permit applications under Section 404 of the Clean Water Act of 1977; these applications may involve public or private lands. This review includes making recommendations for minimizing habitat losses in all proposals for new or modified roads, pads, well sitings, and operations.

Department of Energy

Arctic Activities

The Arctic and Offshore Research subprogram of the DOE's Advanced Process Technology program was established to enhance petroleum-energy development by examining critical natural forces (such as sea-ice and subsea-permafrost formation) and their effects and to estab-

lish a data base for Arctic parameters. Much of the subprogram's efforts are directed at offshore development (Morgantown Energy Technology Center, 1988); onshore objectives involve enhanced oil recovery and study of heavy oil, oil shale, and tar sands.

In 1987, the DOE continued developing the Arctic energy-related technology data base (AORIS), sponsoring seminars (Morgantown Energy Technology Center, 1987d), coordinating interagency research, and studying the applicability of recovery techniques to Arctic petroleum occurrences.

AORIS is a computerized information service designed to assist the technological and planning community in the development of Arctic oil and gas resources. It has three principal components: a directory that lists 85 data bases containing Arctic energy-related information and how to access them; a bibliographic/management information system (B/MIS) containing approximately 9,000 references and abstracts on energy-related research; and a scientific and engineering information system containing approximately 600 quantitative data sets, in both tabular and graphical formats,



Figure 9. Yukon Flats National Wildlife Refuge, potential site of seismic exploration permitted by the Fish and Wildlife Service. Photograph by W.W. Knauer, III.

on sea-ice characteristics from the B/MIS citations. AORIS also contains much unpublished information on the Arctic.

Sea-Floor-Soils Research

To improve Arctic petroleum-development technology, the DOE sponsored sea-ice and sea-floor-soils research through several institutions and agencies. At the University of Alaska, research was on ice-island generation from the Canadian Islands ice shelves and their drift paths into the Alaskan Beaufort Sea. Several ice islands that have calved off the Canadian Ellesmere Island ice shelves during the past few years are being electronically tracked in hopes of developing a drift-simulation model. Most of these buoy-equipped ice islands are currently located off Ellef Ringnes Island, about 450 miles west of Greenland, and are slowly proceeding southwest toward Alaska.

Through the U.S. Army's Cold Regions Research and Engineering Laboratory, in cooperation with the USGS, research is designed to determine the seasonal changes in temperature and salinity at the seabed and how those changes influence seabed freezing and the occurrences of ice-bonded permafrost. During August 1985, four instrument packages that measure temperature and salinity values at the seawater/seabed interface were deployed in Harrison and Prudhoe Bays. Information was collected hourly, and the instruments and data were retrieved in August 1986. The data show very noticeable seasonal changes in temperature and conductivity. The greatest variability and highest temperatures occur during the open water period. Temperatures at the seabed are very low and range between -1.5 and -2.0 °C for more than 9 months. These temperatures and computed freezing point data suggest that seasonal seabed freezing can occur most of the winter.

Research conducted by Sandia National Laboratories, in cooperation with the Minerals Management Service, was on measuring acceleration and velocity responses of the sea-floor soils to strong earthquakes. In 1986, a redesigned Seafloor Earthquake Measurement System (SEMS II) unit, deployed near Shell's Ellen-Elly platforms about 10 mi west of Long Beach, Calif., in 250 ft of water, monitored two southern California earthquakes. The preliminary analysis of the data collected by SEMS II indicates that there is a significant difference between the vertical acceleration and the horizontal accelerations at the seabed site of SEMS II. The horizontal accelerations are almost an order of magnitude larger than the vertical acceleration. At the land-based sites, the horizontal and vertical accelerations were similar. Further analysis and research may reveal other significant differences. Progress toward developing reliable soil loading models from earthquake data will depend on collecting additional data from both seabed sites and nearby offshore platforms for earthquakes large enough to cause significant motion of the platforms.

Petroleum Research

A primary petroleum target is gas-hydrate reservoirs, which contain gas in a solid, icelike form. Occurrences of such hydrates have been identified on Alaska's North Slope, and the technology for characterizing and developing this resource is under study as part of the DOE's Environmental and Advanced Research subprogram. Subprogram efforts have recently been concentrating on laboratory testing of natural and synthetic hydrates to define the pressure and temperature conditions and geophysical and mechanical properties in both inhouse and contractors' facilities (Morgantown Energy Technology Center, 1987b). Arctic research studies to determine the in-place conditions of gas-hydrate deposits have been initiated by the DOE in cooperation with the USGS and with ARCO Alaska, Standard Oil Co., Exxon, and CONOCO. As part of the research on gas hydrates, geological basin reports have been developed for a number of offshore areas. The series has been titled "Geological Evolution and Analysis of Confirmed or Suspected Gas Hydrate Localities." Volume 10 is Basin Analysis, Formation, and Stability of Gas Hydrates of the Aleutian Trench and the Bering Sea (Krasen and Ciesnik, 1987). This series of studies is being conducted by GeoeXplorer International, Inc.

The DOE's research on deep-source gas is focused on evaluating the potential for recovering gas from depths greater than 30,000 ft, based on the hypothesis that natural gas would be generated in sediments carried to these depths by tectonic processes. Primary reservoir targets are former and active subduction zones where suitable sediments have been encapsulated. Recent study areas include the Yukon Flats near Fairbanks, the Alaskan Range of south-central Alaska, and the eastern Aleutian Trench (fig. 8), where cooperative stratigraphic, structural, and magnetotelluric studies have taken place (Morgantown Energy Technology Center, 1987b).

Arctic National Wildlife Refuge

With the enactment of ANILCA in 1980, the Arctic National Wildlife Range in northeastern Alaska was enlarged to 18.06 million acres and renamed the Arctic National Wildlife Refuge. Approximately 8 million acres of the ANWR was designated wilderness, to be managed under terms of the Wilderness Act (78 Stat. 892). Subsequently, other land additions have increased the size of the refuge to about 19.5 million acres.

Section 1002 of ANILCA pertains to an approximately 1.5-million-acre strip of the coastal plain of ANWR, now known as the 1002 area (fig. 8). Section 1002 requires the Secretary of the Interior to: (1) conduct a comprehensive, continuing baseline study of the fish and wildlife resources of the 1002 area, (2) develop guidelines to initiate and monitor an oil and gas exploration program, and (3) prepare

a report to Congress describing the fish, wildlife, and hydrocarbon resources; the potential impacts and development scenario for petroleum exploration and production; and recommendations regarding possible exploration, development and production for oil and gas should those activities be allowed in the 1002 area.

The FWS was designated as principal coordinator of the Section 1002 resource assessment, and that agency, the BLM, and the USGS prepared an interagency memorandum of understanding in 1983 for the research and writing of the 1002 report for the Congress. The specific agency roles and research are described in the "1987 Annual Report on Alaska's Mineral Resources" (Bohn, 1987, p. 20-24) and in the report to the Congress (Clough and others, 1987). During 1987, Alaska Federal agency activity regarding the 1002 area focused on responding to political and public inquiry regarding the final 1002 report findings.

Fish and Wildlife Service

The 1002 area draft report to Congress, "Arctic National Wildlife Refuge, Alaska, Coastal Plain Resource Assessment, Report and Recommendation to the Congress of the United States and Legislative Environmental Impact Statement," was released on November 24, 1986 (U.S. Fish and Wildlife Service and others, 1986). The public-comment period extended through February 6, 1987, and three hearings were held on the report: January 5, 1987, in Anchorage Alaska; January 6, in Kaktovik, Alaska; and January 9, in Washington, D.C.

More than 11,000 letters were received during the public-comment period. Approximately two-thirds favored opening the 1002 area of the coastal plain to oil and gas leasing; one-third supported no development and a wilderness designation for the area.

The final report was released on April 20, 1987, and transmitted to Congress on June 1, 1987 (Clough and others, 1987). It includes a separate 998-page volume of all substantive comments received from the public, as well as various opinion letters and substantive written testimony received at the public hearings. The Secretary of the Interior recommended that the Congress authorize full leasing of the 1002 area, in an orderly oil and gas leasing program which avoids unnecessary adverse effects on the 1002 area's wildlife, habitat, and environment.

The Fish and Wildlife Service has responded to numerous inquiries from the Congress and from various other government agencies, as well as from the Government of Canada, concerning the potential for oil and gas exploration and development in the area. Numerous legislators and staff visited the 1002 area during the summer of 1987. Several pieces of legislation are pending, ranging from bills that would allow full leasing of the coastal plain to bills that would designate the entire area as wilderness.

In addition to submitting the 1002 report to Congress, the Department of the Interior negotiated with six Native entities (Koniag, Inc.; Doyon, Limited; Gana-A-Yoo, Limited; Native Lands Group, L.P.; Akhiok-Kaguyak, Inc.; and Old Harbor Native Corporation) in the proposal of extensive land exchanges involving approximately 891,000 acres of Native-owned inholdings in seven National Wildlife Refuges (Alaska Maritime, Innoko, Kanuti, Kenai, Kodiak, Nowitna, and Yukon Delta) for oil and gas rights to approximately 166,000 acres on the coastal plain. The Fish and Wildlife Service was requested on January 14, 1988, to prepare a Legislative Environmental Impact Statement for these proposed exchanges.

U.S. Geological Survey

The geologic interpretations and contributions to the final 1002 report and recommendations to the Congress (Clough and others, 1987) marks the culmination of several years of geologic and geophysical studies by the U.S. Geological Survey and the Bureau of Land Management. This work represents an important part of the USGS' North Slope section of the Evolution of Sedimentary Basins Program. An important product of this study is a newly compiled geologic map of the northern part of the ANWR (Bader and Bird, 1986). In addition, a collection of 23 technical papers summarizing the petroleum geology used in assessing the oil and gas resources of the coastal plain area was published in late 1987 as U.S. Geological Survey Bulletin 1778 (Bird and Magoon, 1987). This publication provides a technical supplement to the final report to Congress. Several of these papers were presented at a seminar in Anchorage on the petroleum geology of the 1002 area during November 1987.

Coal and Peat Resources

In 1987, the United States produced a record 910 million short tons of coal, as predicted by the National Coal Association. Alaska's coal production was also a record, of 1.51 million short tons (Green and Bundtzen, 1988a). Alaska coal production in 1987 was valued at \$42.4 million, an increase of nearly \$2 million over the 1986 value, and the fourth most valuable mineral commodity to the State of Alaska (Green and Bundtzen, 1988a).

Alaskan coal exports to Pacific Rim markets increased during 1987, with Taiwan importing 133,100 tons of coal for blending and boiler tests, Korea importing 645,000 short tons for electric power generation, and Japan importing 24,000 tons of steam coal for electric power system use (Green and Bundtzen, 1988a).

During 1987, industrial activity focused on three Alaskan coal fields: Beluga, Matanuska Valley, and Healy (fig. 10). For the Beluga field, the State of Alaska approved a surface-

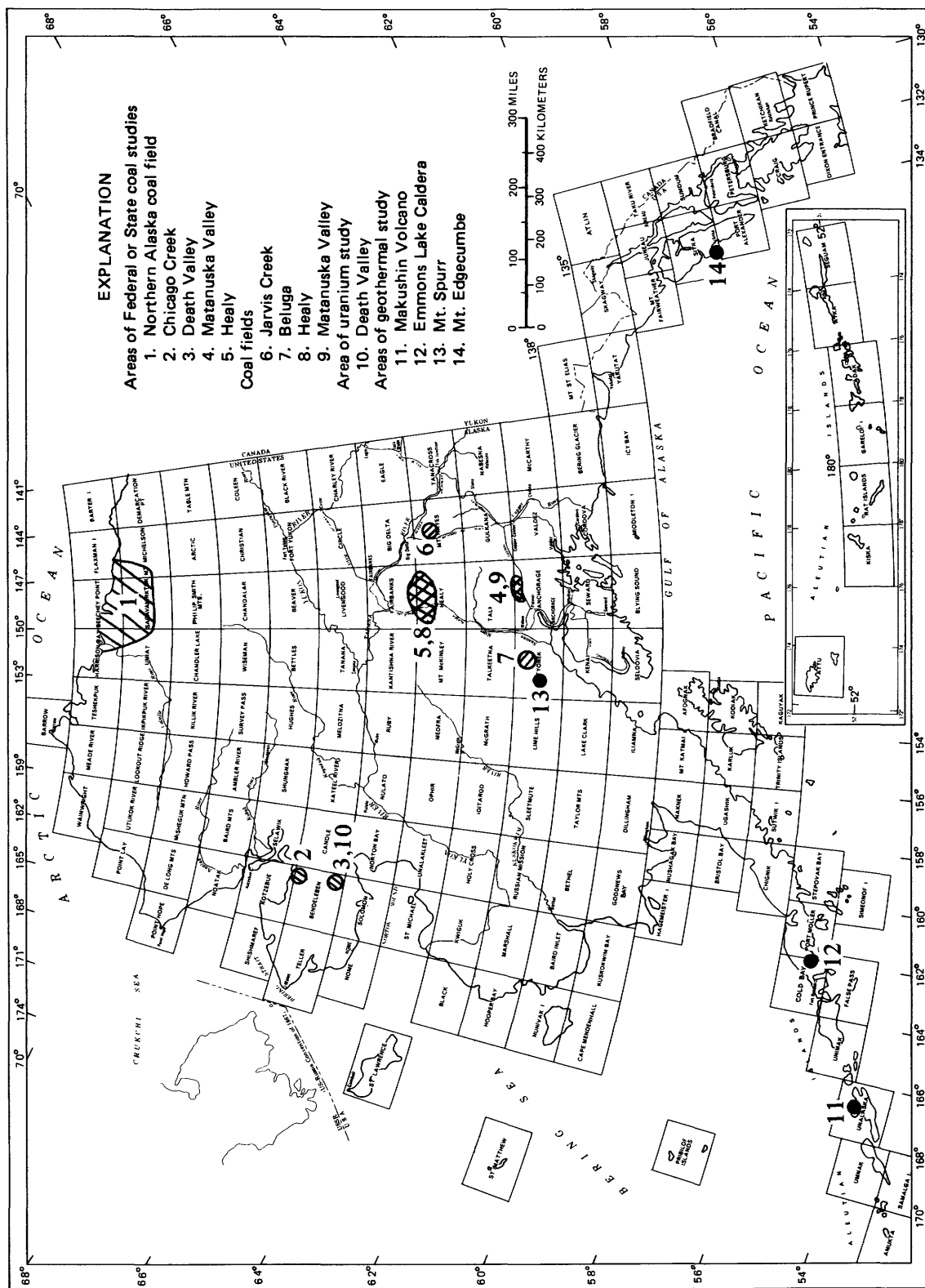


Figure 10. Areas of potential coal and peat, uranium, and geothermal resources mentioned in the text.

mining permit for the Diamond Alaska coal project, and construction on the 3,596-acre mine site could begin in 1988 (Alaska Journal of Commerce and Pacific Rim Reporter, Sept. 7, 1987). Coal from the mine, located 45 miles west of Anchorage across Cook Inlet, will go to a port north of Granite Point on Cook Inlet via truck, with final plans calling for a conveyor system to move the expected 15 million tons per year. In the Matanuska coal field, Rocky Mountain Energy and Idemitsu Kosan of Japan have formed a joint venture to explore the possibility of strip mining high-grade coal near Sutton. The companies plan to mine about 300,000 short tons annually for export to Japan (Anchorage Daily News, Mar. 3, 1987). The proposed site, a 1.5 mi² area, contains minable reserves estimated at 32–60 million short tons. Usibelli Coal Co., located near Healy (fig. 10), and again in 1987 the only active coal mine in Alaska, produced 1.5 million tons of coal, up 1 percent over 1986 production. In the future, Usibelli Coal Co. is expected to provide about 550,000 short tons of low sulfur coal per year to a new \$250 million electric generation plant near Healy, Alaska, planned by Brown and Root USA and Usibelli Coal Mine. The 100–150 megawatt plant would be the largest coal-fired facility in Alaska and could come online in the mid-1990's, supplying power into the Anchorage-Fairbanks powerline with up to 15 percent of their energy needs (Anchorage Times, July 17, 1987).

The Alaska Division of Geological and Geophysical Surveys continued its investigation of the Chicago Creek coal field (fig. 10). Studies by the State indicate that coal-fired electrical power is an attractive alternative to diesel power generation in Kotzebue, with estimated reserves in the Chicago Creek field of 4.7 million tons of coal; a 30-year supply for Kotzebue, nearby villages, and the Red Dog Mine (presently under construction) (Alaska Journal of Commerce and Pacific Rim Reporter, May 1987).

The Alaska Department of Natural Resources' Division of Mining advertised 640 acres for coal leasing in the Wishbone Hill District of the Matanuska coal field (fig. 10) (Alaska Journal of Commerce and Pacific Rim Reporter, July 6, 1987). The State estimates 14 million tons of recoverable coal with an average heating value of 12,460 Btu per pound are producible from this acreage.

Alaska has one of the world's largest peat resources, estimated to be five times the energy potential of Prudhoe Bay. Currently, peat mined in Alaska is used primarily in agriculture and greenhouses as a soil conditioner, while minor amounts are burned locally in villages for heat. Peat production continued to decrease in 1987 to 46,000 yd³, down 4,000 yd³ from 1986. Future use of peat may increase, as the Valley Energy Corp. plans to use peat as a clean economic heat fuel for producing electricity for export. The group has recently purchased 120 acres near Willow, where it plans to build peat power plant and processing facilities (Anchorage Daily News, Aug. 18, 1987).

ACTIVITY BY FEDERAL AGENCIES

U.S. Geological Survey

Coal of late Cretaceous to Tertiary age in the eastern part of the Northern Alaska coal field (fig. 10) has been sampled as part of the USGS Sedimentary Basins program. This program includes studies of depositional, structural, diagenetic, and thermal processes useful in resource analyses. Analysis of two coal cores from the Sagwon Bluffs along the Sagavanirktok River and 12 channel samples from exposures along Juniper Creek and Shaviovik River indicate that the Tertiary coals have a mean sulfur content of 0.58 percent (0.1 to 1.6 percent), mean ash content of 7.6 percent (2.0 to 20.0 percent), and a mean apparent modal rank of subbituminous B (lignite A to subbituminous C). Coal bed correlation, both surface and subsurface, indicates that the size of the resource area is larger than 4,000 mi² (Roberts, 1988).

Studies in the Healy coal fields (fig. 10) indicate that element distribution is drastically affected in areas where oxygenated ground water reacts with the upper portion of the coal and where plant roots uplift certain elements during the peat-forming stage. This area was extensively sampled in 1987 and detailed investigations are in progress. The contents of beryllium, chromium, molybdenum, niobium, scandium, vanadium, ytterbium, and yttrium are anomalously higher (2–400 times) in the upper interval of the No. 3 bed. These elements show no correlation with ash content and may have been transported by oxygenated solutions moving through the overlying sandstone, and then removed from solution by the interaction of ground water with the upper portion of the coal. The sulfur content ranges from 0.03 to 0.28 percent, with a mean of 0.12 percent; 5 times lower than that of the average U.S. Tertiary coal. Most of the sulfur is concentrated in the upper one-fifth of the 18-foot bed and may be the result of the ability of peat-forming plants to uplift certain elements needed as nutrients during growth (Affolter and Stricker, 1987).

U.S. Geological Survey personnel have been investigating the thickest known coal bed in the State. A 185-ft-thick bed is located on the Seward Peninsula in the Death Valley area (fig. 1). This Eocene coal bed has a basalt lava flow for roof rock, and the basal portion of the coal is enriched in tungsten and uranium. The apparent rank ranges from semi-anthracite near the top of the bed to subbituminous A near the base (Stricker and Affolter, 1988).

Bureau of Land Management

The BLM continued its management of the Delta Coal Co.'s lease in the Jarvis Creek coal field south of Delta Junction (fig. 10). Coal from this field is a potential feed stock to produce gas, which in turn would be used to generate electrical power for the U.S. Army base at Fort Greeley, south of

Delta Junction. Interest in additional coal leasing on Federal land is low at this time.

U.S. Bureau of Mines

The USBM prepared a report in 1987 on 247 coal deposits in Alaska, including deposits that are current producers, those with commercial production potential, and those cited in the literature (Meyer, 1988). The deposit data are compiled from property listings and evaluations in the Bureau's MAS data base, and a literature search. The report includes salient nonconfidential information on the principal coal deposits in Alaska, a summary of coal mining activity in Alaska, and brief discussions on the infrastructural and institutional factors affecting coal development in Alaska.

Fish and Wildlife Service

The Fish and Wildlife Service commented on requested permit modifications for the Usibelli Coal Mine in Healy, Alaska.

Uranium Resources

The uranium industry in the United States continues to be depressed because of low prices and severe competition from other countries, primarily Canada. In 1985, the U.S. Department of Energy declared the uranium industry in the U.S. nonviable. This finding requires that the Administration take action, such as import restrictions, to protect the domestic uranium industry. The ruling is still in effect and action by the Congress to vitalize the domestic mining and milling industries is pending (Finch, 1988). In 1986, 13.8 million lbs. of U_3O_8 were produced and the spot market price hovered around \$17.00 per pound (Chenowith, 1987). Exploration expenditures were expected to decrease slightly in 1987, but the figures are not yet available. There was no production of uranium in Alaska in 1987, because of continued high exploration and production costs.

In the conterminous United States, moderate interest continues in exploring for uranium deposits that are relatively high-grade and economical to produce. Two kinds of deposits, those associated with surficial accumulations of organic matter, and those in solution-collapse breccia pipes, are of this type.

ACTIVITY BY FEDERAL AGENCIES

U.S. Geological Survey

The USGS continues moderate, but declining expenditures on exploration research for uranium, primarily carried out by the Branch of Sedimentary Processes. Dickinson and others (1987) published a report on the potentially commercial Death Valley uranium deposit on the Seward Peninsula (fig. 10) during 1987. This deposit, discovered in 1977 by

an airborne radiometric survey, is the largest known uranium deposit in Alaska, and the most northerly known sandstone-type uranium deposit in the world. Studies from exploratory drilling indicate the average grade of the uranium ore is 0.27 percent U_3O_8 in beds averaging 3 m thick. Minimum calculated reserves from the deposit are 1 million lbs U_3O_8 .

Geothermal Resources

Alaska's geothermal resources have historically been used on a small, highly localized scale for recreation, space heating, and agriculture. However, widespread young volcanic activity on the Aleutian Islands, the Alaska Peninsula, the Wrangell Mountains, and elsewhere in the State is indicative of the potential for geothermal energy production to serve population centers.

Makushin Volcano, near Dutch Harbor and Unalaska (fig. 10), has long been considered a potential source of power. Recent studies to delineate the geothermal resource at Makushin have been jointly funded by DOE and the Alaska Power Authority (APA). In 1987, APA contracted for follow-up design and feasibility studies (Dames and Moore, 1987; Power Engineers, 1987), market analysis (R.W. Beck, and Associates, 1987), and environmental studies (Sundberg and others, 1987) of the proposed Makushin geothermal power generating facility. Demand for electricity is increasing in Unalaska due to a growing shore-based fish processing industry. Should the project proceed, it would be under cooperative agreement between the APA and the Aleut Native Corporation.

ACTIVITY BY FEDERAL AGENCIES

U.S. Geological Survey

The USGS is conducting mapping projects at three volcanoes which may prove to be potential sources of geothermal energy: Mt. Spurr, near Anchorage, Mt. Edgecumbe, near Sitka, and Emmons Lake caldera, near Cold Bay (fig. 10). The objective of these mapping projects is to establish the geologic history of each volcano, both in terms of chemical evolution and distribution of eruptive products, thereby providing the basis for an evaluation of the available geothermal resource.

NONFUEL-MINERAL RESOURCES

Metallic Minerals

INDUSTRY ACTIVITY

Alaska's metallic mineral industry experienced a growth period during 1987. Data obtained from the State of Alaska (Green and Bundtzen, 1988a) indicate that Alaskan metal

Table 7. Mining production in Alaska, 1984-87

[Assumed average 1987 prices: sand and gravel, \$2.61/ton, varying with location; gold, \$455/troy oz; coal (FOB Healy), \$28.07/ton; building stone, \$6.45/ton; peat, \$6.50/yd³; silver, \$7.20/troy oz. Other values provided by mine producers. Data from Green and Bundtzen (1988a). NR, no report; W, information held by mine operators]

	Volume				Value (in thousands of dollars)			
	1984	1985	1986	1987	1984	1985	1986	1987
Gold (troy oz)	175,000	190,000	160,000	229,706	63,000	61,175	60,800	104,516.2
Sand and gravel (million tons)	27.0	28.2	20.9	16.4	95,000	112,062.7	75,761.5	42,659.8
Coal (tons)	849,161	1,370,000	1,492,707	1,508,927	23,775	39,730	40,100	42,354.5
Building stone (million tons)	2.7	2.5	4.2	1.8	16,000	12,150	20,320	11,620
Tin (lb, metal)	225,000	300,000	340,000	288,000	400	650	890	460
Silver (troy oz)	20,000	28,500	24,000	54,300	159	171	134.4	391
Peat (yd ³)	125,000	85,000	50,000	46,000	859.4	552.5	350	299
Jade, soapstone (tons)	5.5	W	2.0	3.6	16.5	W	12	78
Tungsten (tons)			120	16.5			22.8	11.4
Antimony (lb)	135,000	65,000	45,000	NR	225.8	98	67.5	NR
Mercury (lb)	380	2,094	912	NR	1.5	10	2.8	NR
Total-----					199,437.2	226,599.2	198,461.0	202,389.9

production in 1987 increased in value by 70.3 percent over the 1986 production, to \$105.4 million (table 7). Expenditures in Alaska for the exploration, development, and production of metals also increased dramatically during 1987, up 37 percent from 1986, valued at \$317.9 million (Green and Bundtzen, 1988a).

Although in general, the metals market remained depressed in 1987, selected metals showed increases. Copper increased in price 128 percent; silver, 19 percent; gold, 25 percent; and platinum, 10 percent. In Alaska, there is a renewed interest in hard rock mining, and 9 major companies started precious-metal exploration or development in the State during 1987 (Anchorage Times, Nov. 30, 1987). As in 1986, more than 400 miners applied for Federal environmental permits during 1987 (Anchorage Daily News, June 28, 1987).

For the first time in 20 years, the value of gold production surpassed the value of sand and gravel to the State of Alaska (fig. 11). Alaska gold production in 1987 is estimated at 229,706 ounces, a 43.6 percent increase in volume and a 72 percent increase in value from 1986. Of this, 223,200 ounces, or 97 percent, was mined from placers (Green and Bundtzen, 1988a). Despite this increase in total gold production, the placer mining industry did not recover from the 27 percent reduction in mine operations experiences from 1985-1986 (Green and Bundtzen, 1988b).

Turbidity requirements for mine discharge water continues to be a source of concern for Alaska's placer miners.

Few miners have been fined but many are not in strict compliance with State law.

The U.S. District Court ruled that mining operations must be curtailed at the close of the 1987 mining season on Federal placer claims involving more than 5 acres until the Bureau of Land Management completes required environmental and subsistence reviews covering the cumulative impacts of mining operations (Alaska Journal of Commerce and Pacific Rim Reporter, Aug. 31, 1987). The BLM may not be able to complete all of the required studies by the mining season of 1988, which would result in at least the temporary closing of some mines. It is estimated that 40 to 50 mines on BLM lands would be affected by the 5-acre minimum size criteria. A Federal judge subsequently ruled that the BLM must review the environmental effects of placer mining operations covering less than 5 acres on national wild and scenic rivers. However, these mines would be allowed to operate in 1988 regardless of the status of completion of the reviews (Anchorage Times, Nov. 10, 1987).

Precious Metals

Exploration and mining feasibility studies continued at a number of known lode gold mines in 1987. In southeastern Alaska, Echo Bay Mines of Canada examined the famous Alaska-Juneau (A-J) Mine near Juneau (fig. 12), but a decision to reopen the mine will probably not be made until

1991 (Anchorage Times, July 27, 1987). The A-J Mine produced 3.5 million oz of gold between 1880 and 1943. In a joint venture, Echo Bay Mines and Coeur d'Alene Mines of Idaho plan to continue exploration of the Kensington Mine 50 miles north of Juneau. The companies estimate reserves of about 425,000 oz of gold (Engineering and Mining Journal, Sept. 1987). Exploration and renovation of the old Chichagof Mine near Sitka (fig. 12) is being undertaken by Golden Sitka Resources. This mine once produced

800,000 oz of gold, and is reported to still contain as much as 300,000 oz of gold. The environmental assessment report is completed, but permits have not yet been granted (Mining Journal, Sept. 18, 1987).

The Grant Gold Mine near Fairbanks (fig. 12), which suspended operations in January of 1986, resumed production in December 1987, employing a new rock crushing system (Anchorage Times, Nov. 30, 1987). Other hardrock gold projects proposed for the Fairbanks area include an open-pit mine in the vicinity of Cleary Summit and a heap-leaching operation on Ester Dome near the Grant Mine (Anchorage Times, Nov. 30, 1987).

The exploration program at the Golden Zone Gold Mine, 150 miles north of Anchorage (fig. 12), is nearly complete. The drilling reports will be evaluated as part of an internal feasibility study and production could begin as early as 1989 (Alaska Journal of Commerce and Pacific Rim Reporter, Sept. 7, 1987).

Elsewhere in the State, Placer Dome U.S. of San Francisco reported promising gold values from exploration drilling at the Rock Creek lode gold prospect near Nome (fig. 12). Alaska Apollo Gold Mines Ltd. continues with exploration for gold and silver in the Aleutian Chain at the Shumagin prospect on Unga Island (fig. 12). A plan for a 200-ton-per-day operation is under study (Anchorage Times, Nov. 7, 1987).

Production continued in 1987 at the two largest gold placer operations in Alaska, the buried placer at Valdez Creek, and Inspiration Gold's offshore dredge near Nome (fig. 12). The Valdez Creek Mine, jointly owned by Camindex Mines, American Barrick Resources, and Sullivan Mines, commenced its fourth year of operation in 1987 and for the fourth consecutive year was Alaska's largest gold producer (Green and Bundtzen, 1988a). Problems with ground water and removal of waste gravel encountered in the 1986-87 season were solved, allowing for significant improvements in mine output from the previous year (Northern Miner, 1987a). The world's largest offshore gold dredge, the *Bima*, completed its second year of operation mining in Norton Sound near Nome, and recovered 36,000 oz of gold between June and November (Petroleum Information, Alaska Report, v. 34, no. 2, Jan. 13, 1988). Mining operations are currently restricted to 120 acres of sea floor per year and in 1987, operations on 60 acres of sea floor began in June and continued until November.

Strategic and Critical Minerals

Exploration tests by the Finnbear Mining and Exploration Company for platinum and associated minerals in the Skwentna River drainage west of the Cache Creek mining district (fig. 12) appear favorable for the occurrence of both lode and placer platinum (Alaska Journal of Commerce and Pacific Rim Reporter, Nov. 9, 1987).

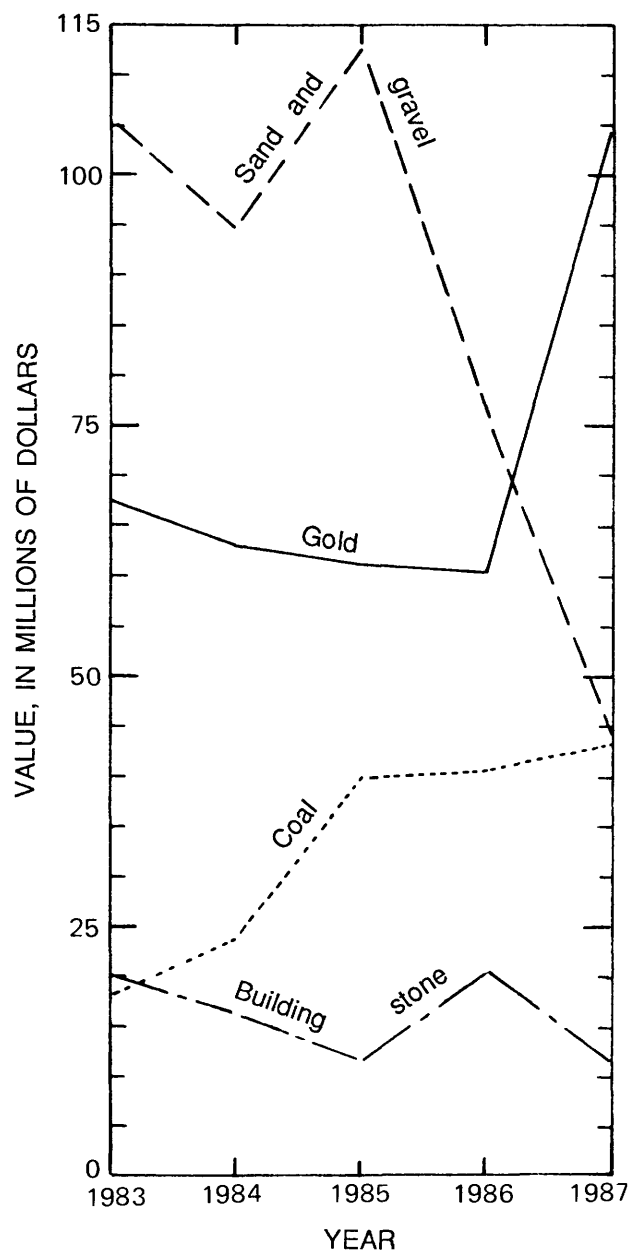


Figure 11. Change in the value of the top four (nonpetroleum) Alaskan mineral commodities for the years 1983 to 1987. (Data from Green and Bundtzen, 1988a; Eakins and others, 1985).

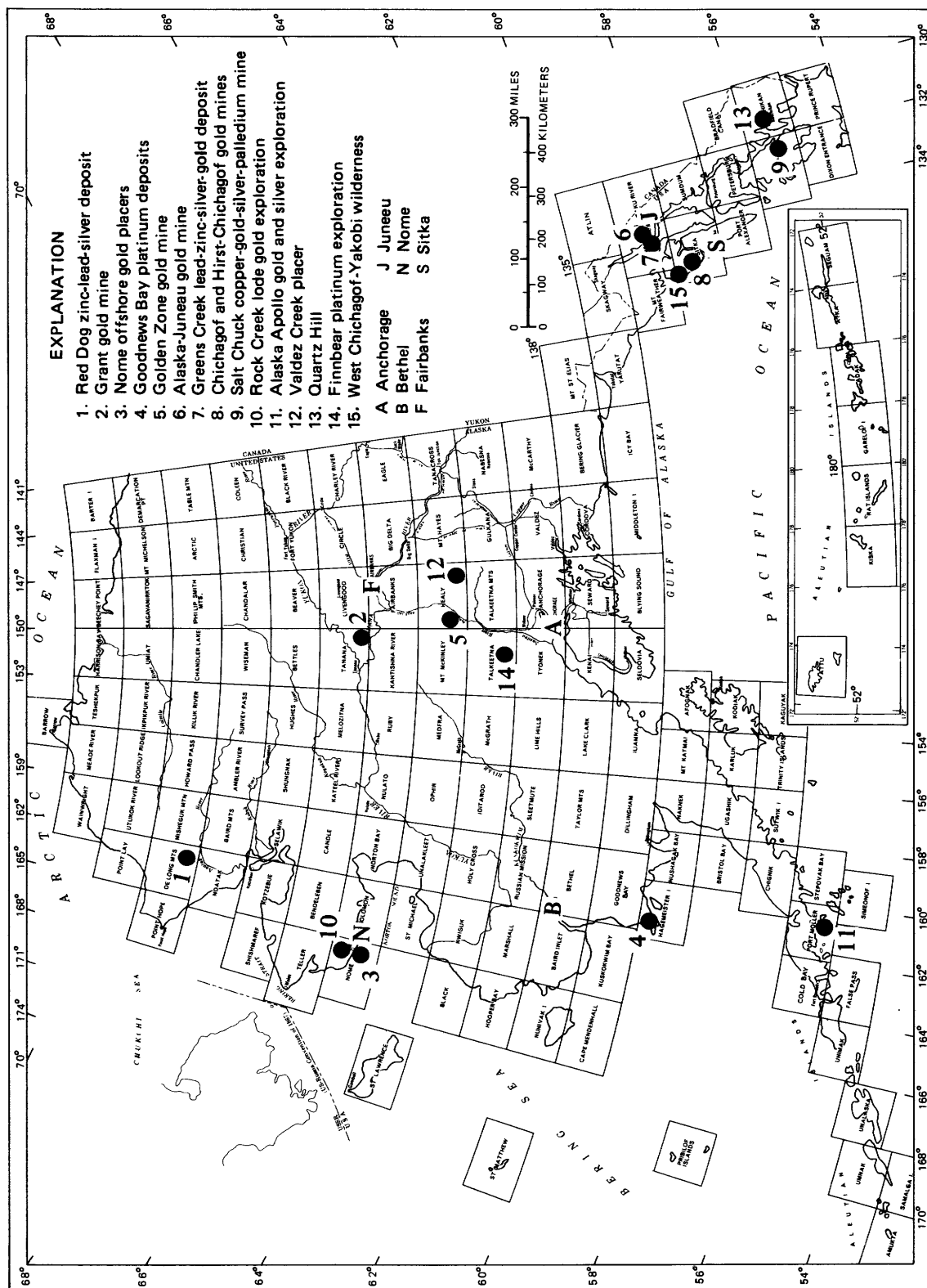


Figure 12. Areas of significant industry activity involving metallic minerals (excluding uranium) in 1987 and mine locations referred to in text.

Surface exploration by American Platinum Inc. has outlined platinum anomalies at the company's Salt Chuck Mine on Prince of Wales Island (fig. 12). This mine, a former producer of platinum and palladium, is believed to contain a low-grade reserve of 285,000 tons of ore. An underground exploration program is planned (Northern Miner, 1987b).

Ashton Exploration Drilling, hoping to put the Goodnews Bay deposit (fig. 12) into production, explored for placer and lode platinum south of Bethel (Alaska Journal of Commerce and Pacific Rim Reporter, Oct. 26, 1987).

Golden Zone Developments Ltd. plans a sampling program in 1988 on a platinum prospect on the flank of the Yuki River, near McGrath (Anchorage Daily News, Jan. 17, 1988).

Other Metals

Development of Red Dog, a world class zinc-lead-silver (Zn-Pb-Ag) deposit located in northwest Alaska (fig. 12), continues on schedule, and the mine could be in production by 1990 (Anchorage Daily News, June 23, 1987). Work was completed in 1986 on the \$2.8 million dock and loading facility at Kivalina. The initial stages of construction of the entire 52-mile-long road from the dock on the Chukchi Sea to the mine site began in July 1987, and were completed by November. In 1988, construction of a fresh-water dam, a tailings dam, overburden stripping, and preparatory earthwork for a mill site are planned. As many as 400 people are expected to be employed in the mining of the deposit and related jobs (Alaska Journal of Commerce and Pacific Rim Reporter, Dec. 28, 1987).

Potentially the country's largest silver producer, the Greens Creek Mine on Admiralty Island in southeastern Alaska (fig. 12), was given final approval for development by its owners in 1987. Due to open in the fall of 1988, the mine will have a production capability of 1,000 tons of ore per day, and a 10- to 30-year lifespan (Anchorage Daily News, Nov. 4, 1987). The mine owners have worked hard at easing the adverse impacts of development in an environmentally sensitive area.

U.S. Borax continues baseline studies and permitting activities on its Quartz Hill molybdenum deposit in southeast Alaska near the Tongass National Forest (fig. 12). Although the deposit contains 10 percent of the world's known reserves of molybdenum, development of the mine is contingent on higher metal prices (Alaska Journal of Commerce and Pacific Rim Reporter, Dec. 28, 1987).

ACTIVITY BY FEDERAL AGENCIES

U.S. Geological Survey

Studies of nonfuel minerals in Alaska are an important part of the USGS programs in Alaska. AMRAP continues as a major USGS program of geologic mapping and mineral

resource assessment of Alaskan lands. AMRAP activities in 1987 were at a level commensurate with the past several years. The TACT program continued its successful operations with the completion of geologic mapping from the Gulf of Alaska in the south to the Yukon River in the north. Locations of 1987 studies are included on figure 13.

Alaska Mineral Resource Assessment Program

AMRAP studies are conducted at four progressively more detailed levels to produce comprehensive assessments of Alaska's mineral and energy resources. Level I studies are statewide in scope; published maps are generally at a scale of 1:2,500,000. In 1987, work continued on maintaining and updating the mineral data base for the entire State, and a major publication on the significant metalliferous lode deposits and placer districts of Alaska was completed (Nokleberg and others, 1987). This USGS Bulletin was prepared by a team of six geologists from the USGS and Alaska Division of Geological and Geophysical Surveys, along with contributions from 54 geologists in industry, State, and other Federal agencies.

Level II studies address large parts of the State; resulting maps are generally at a scale of 1:1,000,000. Two studies related to the metallogenesis of the eastern Alaska Range were published (Aleinikoff and others, 1987; Lange and others, 1987). Studies continued on the geology and mineral resources of the Alaska Peninsula.

Level III studies continue to receive the major effort of AMRAP (fig. 14), consisting of multidisciplinary evaluations involving team studies of selected 1° × 3° quadrangles. Geologic, geochemical, and geophysical data are gathered to produce an inventory of areas having mineral resource potential. Studies are in progress in 29 quadrangles. Final reports for the mineral resources of the Bendeleben and Solomon quadrangles are complete and will be published in 1988. Fieldwork is complete and reports in preparation for the Baird Mountains, Port Moller, Stepovak Bay, Simeonof Islands, Mount Katmai, Naknek, Hagemeister Island, Goodnews, Iditarod, Anchorage, Valdez, Killik River, and Chandler Lake quadrangles. Fieldwork continues in the Livengood, Gulkana, Juneau, Taku River, Petersburg, Bradfield Canal, Bethel, and Lime Hills quadrangles. Preassessment studies for planning purposes are being added to the AMRAP program, and evaluations for 8 quadrangles are due by June 1989. Quadrangles with completed preassessments include Table Mountain, Lime Hills, Bethel, and Seldovia. Level III AMRAP projects publish an assessment of the mineral resources of the quadrangle examined. To date, resource assessments have been published for 20 quadrangles (fig. 14).

Level IV studies consist of detailed mapping (at a scale of 1:63,360 or larger) of mining districts, specific mineral deposits, and related subjects. Among the level IV work

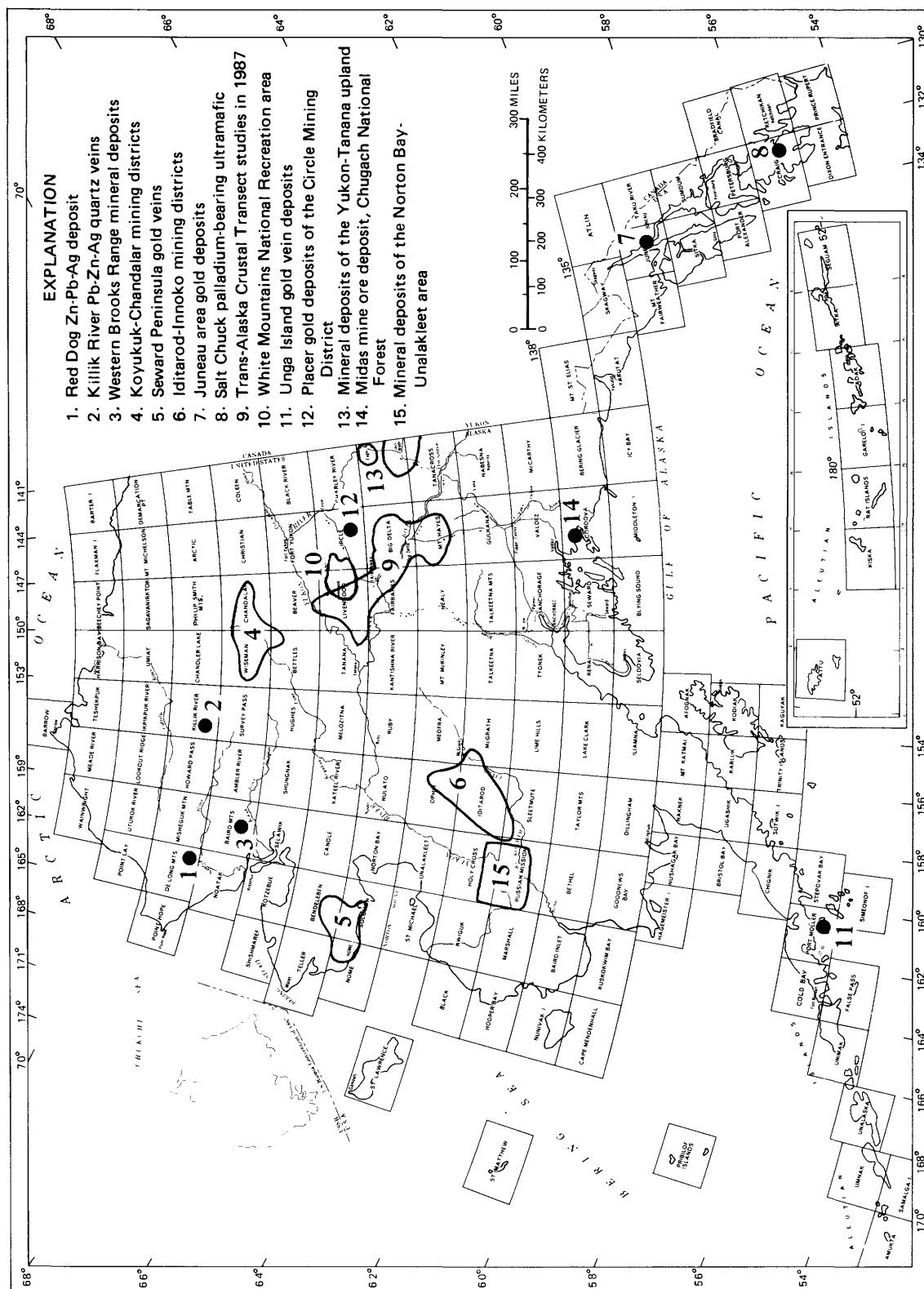
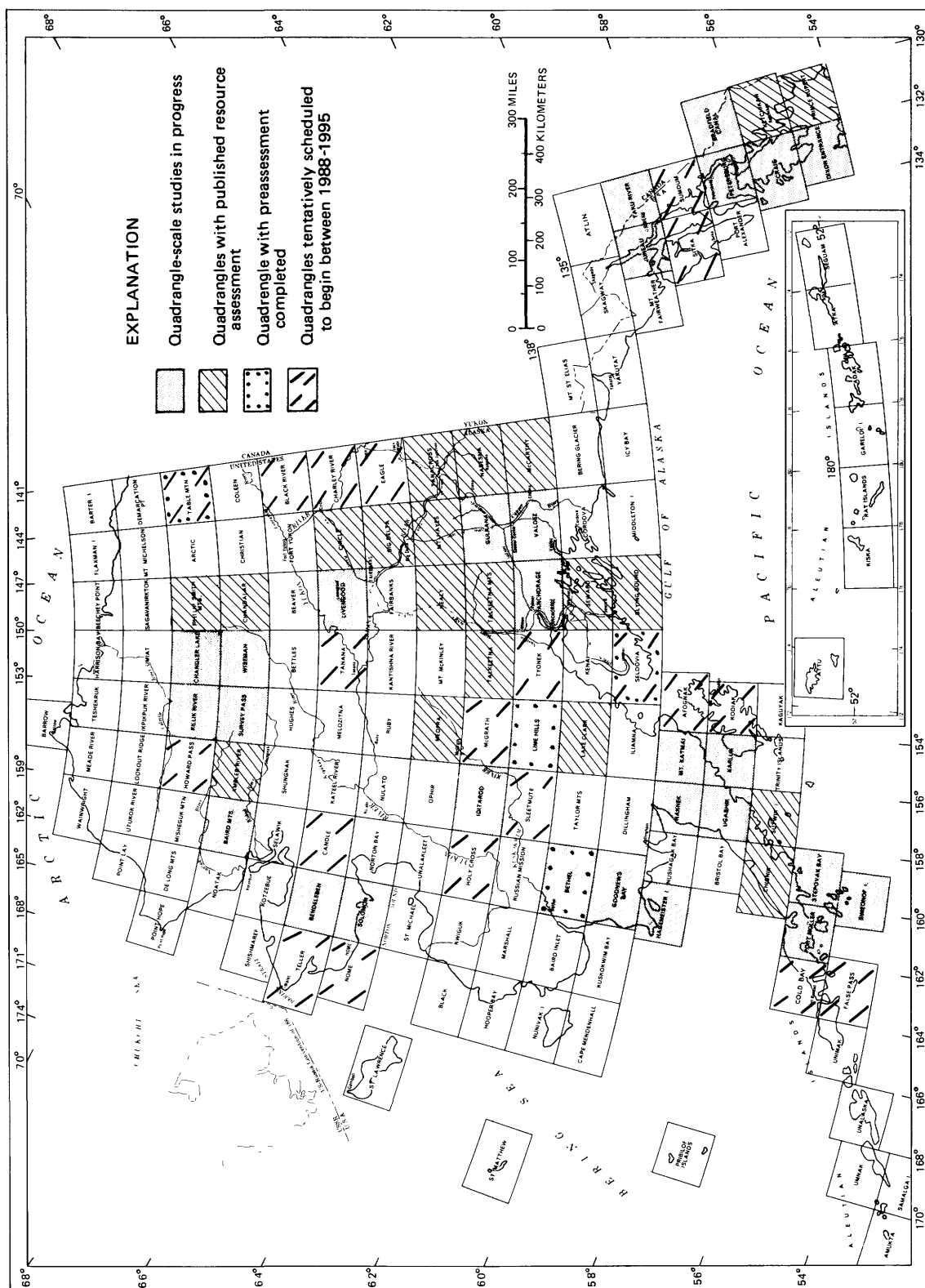


Figure 13. Locations of U.S. Geological Survey level IV, metallic-mineral studies in 1987.



begun in 1987 are studies of gold vein deposits in the Unga Island (Apollo Mine) area on the Alaska Peninsula (fig. 13), igneous rocks of the Talkeetna Mountains, and metamorphic studies in central Alaska. Level IV studies in the western Brooks Range in 1987 included examination and sampling of Pb-Zn-Ag quartz veins in the Killik River quadrangle (fig. 13), and detailed re-logging of core from the Red Dog massive sulfide deposit (fig. 13). The locations of level IV studies are shown in figure 13, and the project titles listed in table 8.

Some of the reports published in 1987 as a result of AMRAP and related USGS programs include: geologic map of the Ugashik, Bristol Bay, and western Karluk quadrangles (Detterman and others, 1987); analytical results of samples collected from the Baird Mountains quadrangle (Bailey and others, 1987a); geology and mineral deposits in southeastern Alaska (Barton and Light, 1987; Brew and others, 1987a, b; Ford and Brew, 1987; Goldfarb and others, 1987a; Koch and others, 1987); spectrographic analyses of stream-sediment samples in Livengood and Circle quadrangles (Bailey and others, 1987b); rock geochemical and sediment analysis of samples in the White Mountains National Recreation Area (Sutley and others, 1987a, b); massive sulfide deposits in the eastern Alaska Range (Lange and others, 1987); geology and mineral resources of the Iditarod quadrangle (Miller and Bundtzen, 1987); geologic map of the Mount Katmai area (Riehle and others, 1987); and analysis and mineralogy of samples from the Mount Katmai area (Bennett and Church, 1987; Bailey and others, 1987c). U.S. Geological Survey Circular 1016, "Geologic studies in Alaska by the U.S. Geological Survey during 1987" (Galloway and Hamilton, 1988), contains numerous short papers dealing with mineral resources and related subjects. Papers dealing with both mineral and energy resources in northern Alaska are present in the all-encompassing report, "Alaskan North Slope Geology," published in 1987 (Tailleur and Weimer, 1987). A bibliography and index of articles in U.S. Geological Survey circulars devoted to research in Alaska from 1975 to 1986 (Reed and Marks, 1987) includes references to many papers on mineral resources.

The third annual McKelvey Forum, entitled "Research on Mineral Resources—1987," was held March 11–12, 1987, in Denver, Colorado. This forum was established to improve communication between the U.S. Geological Survey and the earth science community. This year's forum included several oral and poster presentations on results of research related to mineral deposits in Alaska; abstracts are published in USGS Circular 995 (Sachs, 1987).

Trans-Alaska Crustal Transect Program

The fourth year of the Trans-Alaska Crustal Transect (TACT) program proceeded on schedule. This program is a major integrated multidisciplinary investigation designed to

Table 8. Level IV studies of the Alaska Mineral Resource Assessment Program and related studies active in 1987 [Project chiefs are listed in parentheses. Projects marked by an asterisk are of statewide scope]

Areal mineral-resource assessments
<p>*Tin commodity studies (B.L. Reed)</p> <p>*Placer gold deposit studies (W.E. Yeend)</p> <p>*Subjective probability estimations of Alaskan mineral resources (W.D. Menzie)</p> <p>Mineral deposits, western Brooks Range (J.M. Schmidt)</p> <p>Metallogenesis, eastern Alaska Range (W.J. Nokleberg)</p> <p>Geology and mineral resources, Yukon-Tanana Upland (H.L. Foster)</p> <p>Geology and mineral resources, Norton Bay-Unalakleet area (W.W. Patton, Jr.)</p> <p>Tin and tungsten deposits, Circle district (B.L. Reed and W.D. Menzie)</p> <p>Ore deposits of Chugach National Forest (S.W. Nelson)</p>
Areal energy-resource assessments
<p>Petroleum potential of the Yukon-Kandik Basin (H.E. Cook)</p> <p>Geologic framework and petroleum potential of the Nenana Basin (R.G. Stanley)</p> <p>Coal studies in the Nenana Basin (C. Wahrhaftig)</p> <p>Genesis of trace elements of the Nenana Basin coal fields (G.D. Stricker)</p> <p>Coal resources of northern Alaska (G.D. Stricker)</p> <p>Uranium potential of Alaskan basins (K.A. Dickinson)</p>
Exploration geophysical studies
<p>Gravity studies (including Red Dog, Haines, and Red Mountain deposits) (D.J. Barnes)</p> <p>Geophysics of the Yukon-Koyukuk Basin and its borderlands (J.W. Cady)</p> <p>Mining geophysics of central Alaska (D.L. Campbell)</p>
Biostratigraphic studies
<p>Brooks Range and Arctic Slope studies (L.N. Marinovich)</p> <p>*Paleozoic and Mesozoic radiolarians (C.D. Blome and B.L. Murchey)</p> <p>*Brachiopod and conodont paleogeography (J.T. Dutro, Jr., and A.G. Harris)</p>
Framework or process studies
<p>Yukon-Koyukuk crustal transect study (W.W. Patton, Jr.)</p> <p>Structural analysis of interior metamorphic terranes (J.H. Dover)</p> <p>Mafic and ultramafic rocks of Alaska (R.A. Loney)</p> <p>Upper Mesozoic stratigraphy of the Alaska Peninsula (R.L. Detterman)</p> <p>*Paleomagnetism of accreted terranes (C.S. Gromme)</p> <p>*Metamorphic-facies map of Alaska (C. Dusel-Bacon)</p> <p>Northwestern Alaska crustal study (A.B. Till)</p> <p>Igneous rocks of the Talkeetna Mountains (B. Csejter)</p> <p>Central Alaska metamorphic studies (J. Dover)</p> <p>Gold mineralization of the Apollo and Shumagin Mines (W. White)</p> <p>Radiometric ages and chemistry of the shallow Tertiary igneous rocks of the Mt. Katmai quadrangle; J.R. Riehle and M.A. Lanphere.</p>
Exploration geochemical studies
<p>Alaska placer gold deposits (J.C. Antweiler)</p> <p>Southern Alaska lode gold deposits (J.R. Goldfarb)</p> <p>Geochemistry in glacial areas (E.B. Evenson)</p>
Isotopic and radiometric studies
<p>*K-Ar studies and radiometric age file (N. Shew)</p> <p>*Lead and oxygen isotope studies (S.E. Church)</p>

study the geology, tectonics, and deep crustal structure of Alaska along a corridor parallel to the Trans-Alaska Pipeline. Major results of the 1987 TACT program were:

(1) completion of the deep crustal seismic refraction surveys across the Alaska Range and Tanana River basin; (2) extension of 1:63,360-scale geologic mapping and specialized geologic studies to the Yukon River (no. 9, fig. 13), resulting in a completed geologic strip map that covers the southern three-fifths of the State along the transect; (3) completion of magnetotelluric surveys from the Gulf of Alaska to the northern Alaska Range; (4) extension of gravity and aeromagnetic modeling to the northern Alaska Range; (5) completion of an aeromagnetic survey in the Middleton Island region of the Gulf of Alaska; (6) presentations and publications on the geology, tectonics, and geophysics of the study area (Fisher and others, 1987; Fuis and others, 1987; Nokleberg and Plafker, 1987).

White Mountains National Recreation Area Project

A cooperative study between the U.S. Geological Survey, the Alaska Division of Geological and Geophysical Surveys, and the U.S. Bureau of Mines to develop mineral information for parts of the White Mountains National Recreation Area, which began in 1986, was partially completed in 1987. In 1986 and 1987, a special study was conducted which included geological, geophysical, and geochemical mapping and resource assessment of the White Mountains National Recreation Area for the Bureau of Land Management. The USGS assessed all or parts of 10 mile-to-the-inch Livengood and Circle quadrangles. Geochemical analyses are published in two reports by Sutley and others (1987a, b). The ADGGS completed a similar study, in even more detail, of parts of 5 Circle quadrangles in the adjoining Lime Peak and Mt. Prindle areas of the White Mountains National Recreation Area. In a report published as a result of this cooperative effort, the ADGGS identified an area with significant potential for lode-tin and lode-gold deposits (Smith and others, 1987). The USGS presented an administrative report to the BLM in October 1987, and released an open-file report on the mineral potential of the area in 1988 (Weber and others, 1988).

Precious Metals

USGS geologists are involved in several studies of precious-metal occurrences in Alaska. Research underway and reports published in 1987 include those on: placer gold in the Circle Mining District (fig. 15; Yeend, 1987); placer gold in the southern part of the White Mountains National Recreation Area (Light and others, 1987); and gold deposits in the Alaska-Juneau system (Barton and Light, 1987; Goldfarb and others, 1987b; Leach and others, 1987a, b; Newberry and Brew, 1987a, b; Pickthorn, 1987). Most level III AMRAP studies also involve some aspect of precious-metal deposits.

Strategic and Critical Minerals

Fieldwork in 1986 on the Salt Chuck deposit in the extreme southeast part of Alaska resulted in the publication of a short report in 1987 on a palladium-bearing ultramafic rock body (Loney and others, 1987). Keith and others (1987) reported the occurrence of platinum-group elements in the Eagle quadrangle. Laboratory analysis of gold samples from the Tolovana and Rampart Mining Districts show platinum (Cathrall and others, 1987).

Other Metals

Studies are continuing on the geology and mineral deposits of the western Brooks Range, Yukon-Tanana upland, and Norton Bay-Unalakleet area, as well as ore deposits of the Chugach National Forest (fig. 13).

U.S. Bureau of Mines

The USBM's AFOC is responsible for conducting four programs under the directorate of Information and Analysis and for coordinating work with other field and USBM research centers throughout the United States.

Minerals Availability Program

In 1987, data including land status for 280 coal deposits and 213 other Alaskan properties were updated and entered into the MILS data base (described in appendix 2). The MILS data base now consists of nearly 7,000 deposits; MAS evaluations have been performed on 53 properties.

Publications from the Minerals Availability Program during 1987 include a report on the feasibility of economic zinc, copper, silver, and gold mining in the Porcupine mining area of the Juneau Mining District by Baggs and Sherman (1987), and a report estimating the remaining lode-gold endowment for selected mining districts in Alaska by Sherman (1987).

In response to a request from Senator Murkowski regarding a proposal from Cook Inlet Region, Inc. (CIRI), the USBM conducted a feasibility study of domestic chromium development using modern ferrochrome processing technology. Emphasis was placed on utilizing local coal resources to accomplish prereduction of chromite ore using a rotary kiln process developed in Germany. For the Alaska portion of this study, the USBM provided estimates of grade and tonnage of material at CIRI's Red Mountain deposit on the southern tip of the Kenai Peninsula (fig. 16); descriptions of the deposit geology; and economic parameters, including a local infrastructure analysis.

Minerals Policy and Analysis

Again during 1987, the USBM's Division of Minerals Policy and Analysis centered its attention on the availability

of land for mineral exploration and development in Alaska. For western and southwestern Alaska, the USBM produced map overlays of land status at a scale of 1:250,000; this information is currently in preparation for publication. Maas (1987) published a report on the availability of land for mineral exploration in the northern region of the State. A report summarizing locatable minerals in Alaska's six regions and a statewide study of land available for the exploration and development of leaseable minerals is in preparation.

A project to catalog and locate mining claims in Alaska on map overlays at a scale of 1:250,000, begun in 1972 and updated every year through 1980, was reinstituted by the USBM in 1987. New overlays showing mining claims to the section level for the 16 quadrangles in southeastern Alaska has been released as USBM Open-File Report 20-73 (USBM 1973, revised).

State Mineral Activities

The State Mineral Officer contributed to the annual preliminary "Mineral Industry Survey," which details sig-

nificant mineral activity throughout the State in the preceding year, by providing updates on the "Alaska Mineral Briefing Profile"; listing of associations and organizations interested in minerals; and meetings, conferences, and symposia of the mineral industry. The State Mineral Officer continues to participate with the interagency team preparing the EIS for the Quartz Hill molybdenum mine project.

Mineral Land Assessment

The USBM conducted mineral land assessment activities during 1987 in the White Mountains study area, Valdez Creek Mining District, and Juneau Mining District (fig. 16).

On a joint mineral resource assessment of the White Mountains (loc. A, fig. 16) by the USBM, ADGGS, and USGS, the USBM conducted a literature search, field reconnaissance, site-specific placer sampling of drainages, and a placer mining feasibility study for the BLM (see Balen, 1988, and Fechner and Balen, 1988). Fifteen placer mineral properties identified in the literature search were sampled and evaluated during this study. Of 265 samples collected during this study, gold was found in 49 samples from



Figure 15. View east over recent placer gold mining operations in Crooked Creek, Circle Mining District. The U.S. Geological Survey is restudying the placers in this historic mining region. Photograph by W.E. Yeend.

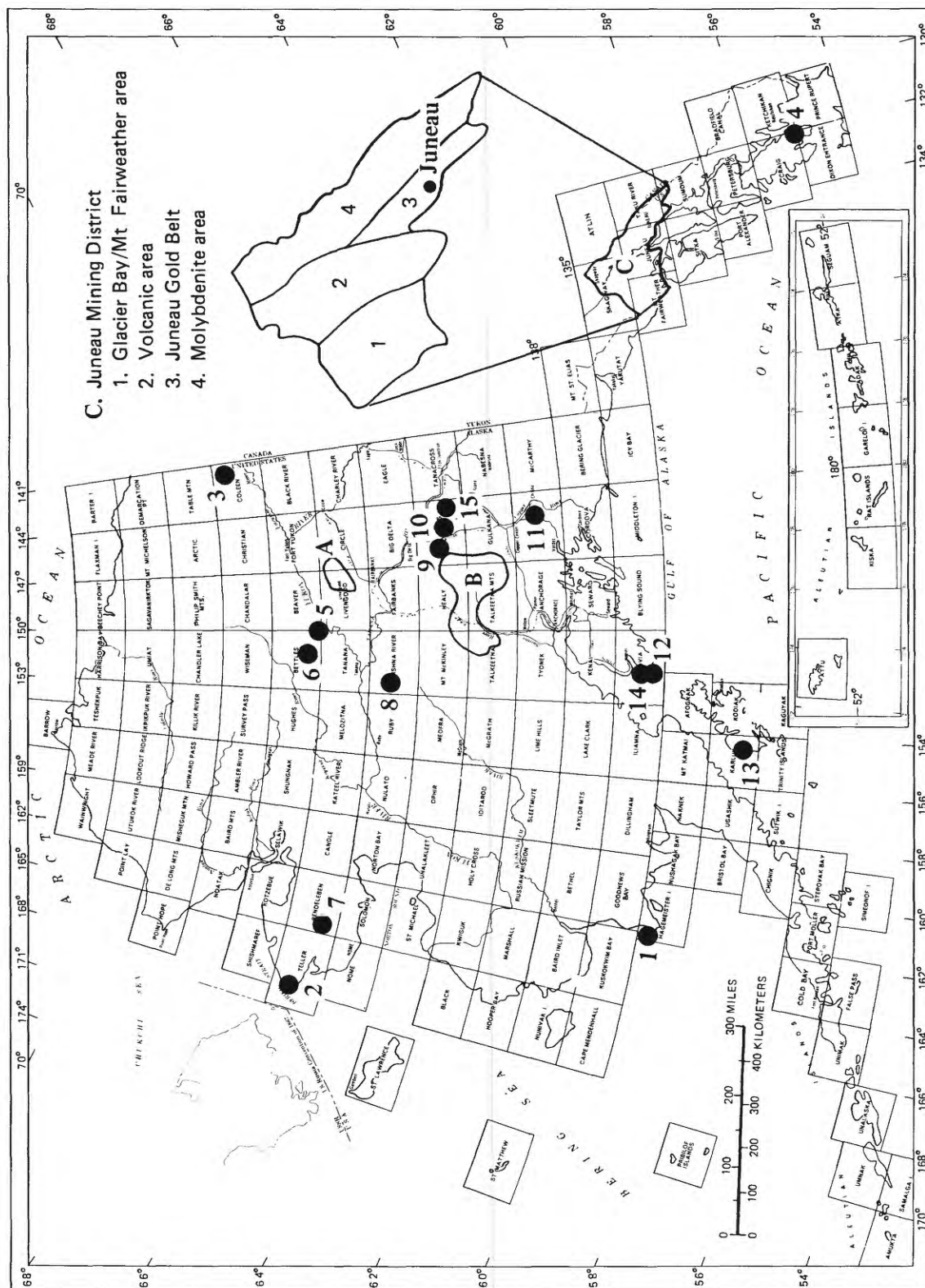


Table 9. Areas of U.S. Bureau of Mines activity in mining districts and critical and strategic minerals in 1987
[See figure 16 for locations. PGM, platinum-group metals; REE, rare-earth elements]

Study Area	Deposit of major interest
A. White Mountain area	Placer gold
B. Valdez Creek Mining District	Placer and lode gold, massive sulfide, tin, chromite
C. Juneau Mining District	Placer and lode gold, volcanogenic and sediment-hosted massive sulfide, molybdenum porphyry

Area of critical and strategic minerals	Element or mineral of interest
1. Goodnews Bay	PGM, Chromium
2. Cape Prince of Wales	Tin to Diomedes Island
3. Old Crow Hills	REE, Tin
4. Southern Prince of Wales Island	REE, Niobium, Uranium, Zirconium
5. Fort Hamlin Hills	Tin, Tungsten, Gold
6. Sithylenkat	Tin
7. Kougarok	Tin, Tantalum, Niobium
8. Cosna	Tin, Silver, Lead
9. Rainy Creek	PGM, Nickel, Cobalt, Copper
10. Rainbow Mountain	PGM, Nickel, Cobalt, Copper
11. Tonsina	Chromium, PGM
12. Claim Point	Chromium, PGM
13. Karluk	Chromium, PGM
14. Red Mountain	Chromium, PGM
15. Miller Creek	PGM, Gold

Beaver, Roy, Mascot, Nome, O'Brien, and Ophir Creeks, and a tributary of American Creek. The majority of these samples, and the highest gold values, were taken from Nome Creek and upper Beaver Creek. The USBM evaluated three types of placer mine models in a mining feasibility study. The study revealed a range of values, with the lowest average value of reserves needed to break even as \$3.84 of gold per cubic yard for a mining operation that owned its own equipment and mined 100 bank yd³ per day for six seasons. The highest average value was \$16.60 of gold per cubic yard for an operation that bought all of its own equipment and mined 100 yd³ per day for two seasons.

The USBM's work in the Valdez Creek Mining District is part of a 4-year project begun in 1987 (loc. B, fig. 16). The study will identify the type, amount, and distribution of mineral deposits; determine ore reserves; study beneficiation technologies for the ore; complete economic feasibility studies; perform probabilistic computer reserve studies; and address economic and legislative effects on mineral development.

Work in the Valdez Creek Mining District included a preliminary literature search, reconnaissance and site-specific sampling, and collection of bulk samples (fig. 17). Mineralized material from the Golden Zone Gold Mine was sent to the Salt Lake City Research Center for metallurgical and beneficiation tests. A placer bulk sample from the Valdez Creek Mine was processed in Anchorage to determine the distribution of gravel and gold sizes. As part of a cooperative agreement with the USBM, the ADGGS is preparing five 1:63,360-scale geologic maps for selected quadrangles within the mining district.

In 1987, the USBM completed the third year of fieldwork in a 4-year study of the Juneau Mining District (loc. C, fig. 16). The program is a cooperative effort involving the USBM and the ADGGS. ADGGS personnel make detailed geologic studies of selected areas, while USBM personnel conduct site-specific examinations. The Juneau Mining District has been subdivided into four areas for evaluation (see figure 16): the Glacier Bay/Mt. Fairweather area (C-1); the Volcanic area (C-2), which includes the West Lynn Canal, Haines, and Porcupine areas; the Juneau Gold Belt (C-3); and the Molybdenite area (C-4), bordering Canada, north and east of the Juneau Gold Belt.

Fieldwork in the Glacier Bay/Mt. Fairweather area is complete. Kurtak (1987) describes the results of USBM investigations in the Johns Hopkins Inlet-Margerie Glacier area. A metallurgical test sample collected by the USBM from the upper and lower nunataks of the Brady Glacier nickel-copper-cobalt/platinum-group metals (PGM) deposit was found to be of insufficient grade to evaluate the recoverability of PGM.

In the West Lynn Canal area, USBM personnel found three zones in metavolcanic rocks of the upper Sullivan River region with significant amounts of mineralization. Quartz veins containing galena, pyrite, and chalcopyrite are common. Samples collected from outcropping massive sulfide material in the volcanics showed gold values up to 3.5 troy oz/ton, and up to 7.3 troy oz/ton of silver, 2.1 weight percent copper, and minor amounts of zinc and cobalt. The three sites are on Federal lands open to mineral exploration and mining. More detailed investigation is needed to determine the full significance of the discoveries and to estimate the amount of mineralized rock present.

In a roadcut 3.1 miles south of Haines, further investigations of copper-gold mineralization included 980 ft of diamond drilling and five trenches totalling 60 ft in length. Samples collected in the vicinity of the occurrence indicate potential for significant gold, copper, and zinc mineralization for at least one mile along the structure. Eight of 13 stream-sediment samples collected in the area contain anomalous gold values.

More than half of the 50 bedrock, pan concentrate, and stream-sediment samples collected at scattered locations on the 12-mile-long Chilkat Peninsula contain anomalous gold,

silver, copper, or zinc values. As part of the joint USBM-ADGGS program, ADGGS crews completed geological mapping and geochemical sampling projects in the Chilkat Range, and in the Takshanuk, Takhinsha, and Four Winds Mountains.

For the Porcupine area during 1987, Still and others (1987) prepared a final report on stream sediment, float, and bedrock samples collected by the USBM and ADGGS.

Geologists completed basic fieldwork on the Juneau Gold Belt during the summer of 1987. Fifteen previously unexamined prospects were located, mapped, and sampled; significant new workings were found at 14 other prospects; and six additional prospects examined during previous years received further work.

During the past three summers, field investigators located and examined a total of 150 mines, prospects, and occur-



Figure 17. USBM geologists sample placer gold on Lucky Gulch in the Valdez Mining District. Photograph by J.M. Kurtak.

ces in the Gold Belt. The USBM found 250 adits, tunnels, and shafts, most of which were open; examined a cumulative total of 56,350 ft of workings; and collected and analyzed 1,530 samples. Redman and others (1987) published the results of the 1986 season in Open-File Report 49-87, and Redman (1987) prepared a publication on the history of the Gold Belt.

In the Molybdenite area (fig. 16), the USBM conducted fieldwork primarily in the Boundary Creek and Yehring Creek drainages. Results of this work indicated that the Boundary Creek drainage has the highest molybdenum potential, although molybdenum occurrences in both drainages are probably minor. Some previously unreported skarn molybdenite-copper mineralization was sampled near Boundary Creek, but the geology of the occurrence indicates only minor potential for any tonnage being developed. In the Skagway area, samples from several narrow quartz-carbonate veins in unaltered granodiorite contain gold values up to 0.67 troy oz/ton and silver values up to 5.8 troy oz/ton. Selected samples from the Mt. Leland ultramafic body show only chromium enrichment, with no significant base, precious metal, or PGM values.

Critical and Strategic Minerals

As part of the studies mandated by ANILCA, the USBM is evaluating occurrences of strategic and critical minerals. Project work in 1987 was divided between studies of tin-tantalum-niobium-rare earth elements (REE) and chromium-cobalt-PGM. Locations of the 1987 USBM project work are shown in figure 16 and listed in table 9.

The USBM continued to evaluate the resource potential for REE and niobium, with associated zirconium, uranium, tantalum, and other lithophile metals on southern Prince of Wales Island (no. 4, fig. 16). The studies are concentrated on a 35-mile-long trend of sodic intrusions and associated mineral occurrences. In 1987, mapping and sampling were conducted in the Moira Sound and Dora Bay areas and a presentation describing REE-bearing dikes near Bokan Mountain was made to the Geological Society of America Cordilleran Section meeting in May (Warner and Mardock, 1987). To date, USBM investigations have delineated more than 40 million tons of mineralized material in 11 deposits. Most of this tonnage contains 0.5 percent or more REE and more than 0.1 percent niobium, in addition to numerous potential by-products. Notably, there is an unusual concentration of the heavy yttrium subgroup amounting to nearly half of the total contained REE.

Elsewhere in Alaska, the USBM conducted strategic and critical mineral studies on tin-silver deposits at Cosna near Tanana (no. 8, fig. 16) on PGM-copper-cobalt-nickel occurrences at Rainy Creek north of Paxson (no. 9, fig. 16), and completed a detailed investigation of the source of PGM in the Miller Creek placers near Chistochina (no. 15, fig. 16).

Placer evaluations of both REE-tin-bearing gravels in the Old Crow Hills in the ANWR (no. 3, fig. 16) and tin-tungsten-gold near the Fort Hamlin Hills in central Alaska (no. 5, fig. 16) indicate that further work is warranted at both locations. Bottom sediment bulk samples were collected to determine the offshore tin placer potential between Cape Prince of Wales and Diomed Islands (no. 2, fig. 16), and mineralogical examination of the heavy mineral concentrates is underway. In 1987, the USBM continued studies of offshore placer PGM-chromite near Goodnews Bay (no. 1, fig. 16) with data reduction and analysis. The possibility of PGM association with southern Alaska chromite occurrences at Claim Point and near Karluk (nos. 12, 13, fig. 16) was also studied.

USBM publications on strategic and critical minerals during 1987 include a report on the distribution of PGM in various deposit types near Rainbow Mountain in the central Alaska Range (no. 10, fig. 16; Barker, 1987). Foley and others (1987) reported on the occurrence of PGM in association with chromite deposits near Tonsina (no. 11, fig. 16).

Researchers at USBM centers in Albany, Oregon, and Salt Lake City, Utah, continued to characterize materials from Alaskan strategic mineral deposits and determine their amenability to beneficiation. For this purpose, several tons of material were collected from tin greisen zones at Sithylemenkat near Bettles and the Red Mountain chromite deposits (nos. 6, 14, fig. 16). Application of the Krupp-Codir direct-reduction pyrometallurgical process is being tested on the Red Mountain chromites. Research continued in Salt Lake City to determine recovery techniques for niobium-REE mineralization from Bokan Mountain and for tin-tantalum-niobium deposits at Kougarok on the Seward Peninsula (nos. 4, 7, fig. 16).

Bureau of Land Management

In 1987, there were filings/recordations of a total of 37,000 Federal mining claims in Alaska. The total number of active mining operations on BLM-administered lands was 155 Notices (5 acres or less total surface disturbance) and 50 Plans (more than 5 acres of surface disturbance) as of September 1, 1987.

BLM Alaska issued 17 mineral patents in FY 1987 for 65 gold claims. A total of 1,837.644 acres was conveyed for these claims, consisting of 8 claims in the Kantishna area, 6 claims in the Nome area, and the remaining 51 claims in the McGrath area.

The ongoing litigation (*Sierra Club v. Penfold et al.*) concerning placer mining activities in the Minto Flats, Beaver Creek, Fortymile, and Birch Creek watersheds has affected the operations of approximately 130 mines. An injunction from this lawsuit prohibits the continuation of mining operations that disturb more than 5 acres in these drainages until the BLM completes environmental impact statements

analyzing the cumulative and synergistic impacts of placer mining on the environment and on subsistence use areas. The court has offered some relief to the affected parties by providing for continued operation through the 1988 mining season for all Notice level mines (that is, those that result in the surface disturbance of 5 acres or less), and offering limited intervenor status for Plan level mines (that is, those disturbing more than 5 acres of surface). The granting of limited intervenor status is contingent upon the individual operator/claimant providing substantial proof to the court that the operation does not contribute to the undue or unnecessary degradation of the environment, either cumulatively or synergistically.

Fish and Wildlife Service

In keeping with its primary mission, efforts of the FWS relating to mineral activity emphasize fish, wildlife, and habitat protection. However, some mining claims were located before refuges were established. By the end of 1987, the number of active mining claims on refuge lands had

been reduced to approximately 175 on 12 of the 16 refuges. Most of the placer mines were in the Togiak and Yukon Delta refuges, and most of the lode mines were in the Alaska Peninsula and Innoko refuges (fig. 3).

Contaminant sampling was conducted on and downstream from the mines at Nyac, on the Tuluksak River, Yukon Delta National Wildlife Refuge, and refuge staff monitored assessment work conducted by Pangea on its Braided Creek claims on the Alaska Peninsula National Wildlife Refuge. The Fish and Wildlife Service also commented on the Greens Creek Mine on Admiralty Island, the Quartz Hill Mine near Ketchikan, the Klag Bay Mine on West Chichagof Island, and on offshore gold dredging in Norton Sound.

National Park Service

The NPS Alaska Regional Office Minerals Management Division is organized into Resource Assessment and Mining and Minerals branches. These branches, composed of physical and environmental specialists, mining engineers, and



Figure 18. USBM mining engineer placer sampling for REE, tin, and niobium in the Old Crow Hills, Arctic National Wildlife Refuge. Photograph by R. Swainbank.

geologists, review and process plans of operations, gather and analyze natural, cultural, and physical engineering information on areas subject to mineral-related activities; evaluate environmental impacts of mining and mineral development activities (fig. 19); conduct claim validity examinations; and develop and implement long-term reclamation programs. In addition to the Regional Office, Denali and Wrangell-St. Elias National Parks and Preserves have professional minerals management staffs of mining engineers or geologists and environmental specialists to implement park-specific aspects of the minerals management program. Major accomplishments during 1987 were:

1. Processing and completeness review for 8 plans of operations for mining activities in 4 different park units; 2 plans were determined to be complete and 1 received approval by the end of the calendar year.

2. Mineral examinations for claim validity determinations were made in 6 park units. In all, 48 placer and 2 lode claims were examined in 1987.

3. Field investigations were conducted for engineering and environmental analyses on the submitted plans of opera-

tions. Additionally, natural resource inventory and evaluations were performed on areas subject to and anticipated for mineral-related activity in 8 park units.

4. Photopaneling and surveying of 319 mining claims in 5 park units was completed.

5. Color infrared and black and white aerial photographs were taken of claim areas in Denali, Gates of the Arctic, and Wrangell-St. Elias National Parks and Preserves, Kenai Fjords National Park, and Bering Land Bridge National Preserve.

6. The second year of a multi-year program of inventory of cultural resources on all mining claims and potential mining access routes was completed in 1987. Fifteen thousand acres were surveyed and 60 cultural resource sites were recorded.

On May 9, 1985, the Department of the Interior was sued by the Northern Alaska Environmental Center and others, over noncompliance with NPS mining regulations in Alaska. On July 22, 1985, the Federal District Court issued a preliminary injunction suspending approval of all existing operations effective the end of the 1985 summer season and



Figure 19. NPS wildlife biologist evaluating impacts to vegetation along mining access route in Gates of the Arctic National Park and Preserve. Photograph by T. Ford.

required NPS to prepare environmental impact statements which assess the cumulative impact of mining on park resources in Wrangell-St. Elias National Park and Preserve and in Yukon-Charley Rivers National Preserve.

The Government filed a motion for reconsideration, which was denied by a District Court order on December 4, 1985. In that court order, the preliminary injunction was amended to include the requirement of a similar Environmental Impact Statement for Denali National Park and Preserve. However, the court provided a mechanism for plan-of-operations approval within the three units prior to completion of the EIS. There were no cumulative impacts; either the NPS or the claimant could petition the court for exemption from the injunction. The court also invalidated clauses in NPS mining regulations that provided for automatic approval of plans of operations if NPS failed to act within 90 days.

In 1987, the following accomplishments were made on the court ordered environmental impact statements: field studies were completed, a geographic information system was established and utilized to evaluate baseline conditions, a cumulative impact methodology was developed and tested, and preliminary alternatives were drafted.

On December 9, 1987, the court ruled that a validity determination is not an essential precondition for review and decision on a proposed plan of operations in an Alaska NPS unit. The NPS has some latitude in determining timing and need for validity examinations and it may not approve operations if sufficient evidence exists to indicate invalidity.

U.S. Forest Service

Greens Creek (fig. 12), one of the largest mining developments in southeast Alaska, is in Admiralty Island National Monument, which is administered by the Tongass National Forest. Development is proceeding under the authority of Section 503(f)(2)(A) of ANILCA. The Greens Creek Mining Co. is aggressively developing the mine; construction of an access road from tidewater to the mine is nearing completion and the construction of a second adit and mill is in progress. Construction is also underway of terminal facilities in Young Bay for personnel and in Hawk Inlet for heavy cargo and concentrates. The Greens Creek Mining Co. plans to begin producing concentrates in spring 1989. Under the provisions of Section 503(e)(1) of ANILCA, Forest Service mineral examiners are evaluating 9 mining claims to determine whether a valid mineral discovery has been made. The evaluation will be completed in July 1988; if a valid mineral discovery is determined, further development of the deposit will be permitted.

In August 1987, the Sealaska Corporation proposed an exchange of their mineral lands in the Cube Cove area of Admiralty Island National Monument for Federal minerals in the vicinity of the Greens Creek project. The Forest Service is presently evaluating Sealaska's proposal.

U.S. Borax and Chemical Corp.'s Quartz Hill molybdenum deposit in Misty Fiords National Monument (fig. 12) is located on a 152,000 acre tract that is excluded from wilderness designation. Section 503(f)(2)(A) of ANILCA provides for the evaluation and development of the deposit. The USFS was the lead agency for the draft EIS released in 1984; a revision became necessary when U.S. Borax provided additional information about marine tailings disposal. Two alternatives for marine tailings disposal are considered in the EIS; disposal in the Boca de Quadra fiord and disposal in the Wilson Arm/Smeaton Bay fiord. The revised draft was released in spring 1987 and the Forest Service's preferred alternative is to dispose of tailings in the Wilson Arm/Smeaton Bay fiord. The preparation of the final mine development EIS is presently in progress.

Abandoned gold mines in the Juneau Gold Belt, on West Chichagof Island, and on Prince of Wales Island are being re-evaluated for potential development. Mining companies are exploring the Kensington and Jualin properties in the Berners Bay area 50 miles north of Juneau, the Hirst-Chichagof and Chichagof Mines at Klag Bay and Kimshan Cove on West Chichagof Island, and the Dawson Mine near the town of Hollis on Prince of Wales Island. These properties include both patented and unpatented mining claims.

Since summer 1984, the Forest Service has been conducting mineral validity examinations on mining claims located in National Forest Wildernesses. These examinations are conducted for the purpose of establishing valid existing rights. If these rights are established, the claimants can proceed with certain exploration and development activities. To date, three such examinations have been completed, all in the West Chichagof-Yakobi Wilderness (figs. 12, 20).

The USFS is updating minerals inventory data for the revision of the Tongass Land Management Plan. A draft of the new plan is scheduled to be issued in December 1989. Mineral resource data, including areas of mineral interest, claim staking and exploration activity, and USGS publications and field investigations (such as the USGS AMRAP program), are being used to update the existing data base. The USFS is working closely with the U.S. Bureau of Mines in this effort. This information will be used to determine areas of the Tongass National Forest where mineral exploration and development are most likely to occur and will provide the USFS with information useful in appropriate land allocation recommendations and decisions.

Industrial Minerals

Sand and gravel production decreased significantly in Alaska during 1987, and for the first time in 20 years was surpassed by gold as the most valuable nonpetroleum mineral commodity in the State (fig. 11). The decline in production that began in 1986 continued in 1987, with a decrease in production of 21.5 percent and a decrease in

value of 43.7 percent (Green and Bundtzen, 1988a). The drop in production of sand and gravel is a result of poor market conditions due to the oil-related slump in construction in urban areas and decline in development on the North Slope.

ACTIVITY BY FEDERAL AGENCIES

Bureau of Land Management

The disposal of industrial mineral materials (sand and gravel) has not been a large activity for BLM Alaska, because of the remoteness of most BLM-administered lands, and because lands near the existent transportation systems have been conveyed to the State of Alaska or to Regional Native Corporations. BLM issued 55 permits during FY 1987, but fewer than half were active. Most of the active sites were associated with maintenance of portions of the transportation system under the jurisdiction of the Alaska Department of Transportation.

Fish and Wildlife Service

In addition to permitting and monitoring small on-going sand and gravel operations in support of local transportation and industry, the FWS continued to monitor the Arctic Slope Consulting Engineers gravel mine on Kaktovik Inupiat Corporation lands adjacent to the ANWR 1002 area; sand and gravel extraction on Nunivak Island, Yukon Delta National Wildlife Refuge; and gravel and armor rock extraction by Ounalashka Corporation, Akutan Corporation, and Dutch Harbor Aggregate Company on Amaknak Island.

U.S. Forest Service

Annually, the USFS permits the removal of many thousands of tons of sand, gravel, and stone. The bulk of this material, in the form of quarried stone, is used in the Tongass National Forest for the construction of timber sale



Figure 20. USFS mineral examiners sample mine in the West Chichagof-Yakobi Wilderness Area. Photograph by R. Griffin.

roads. Lesser amounts are used by State and local governments for the construction and maintenance of breakwaters, airports, and roads. Over 200,000 cubic yards of rock and sand, worth about \$140,000, has been sold to Greens Creek Mining Co. for the development of their mine on Admiralty Island National Monument.

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APPENDIX 1.—ALASKA MINERAL REPORTS RELEASED DURING 1987 AND EARLY 1988

The following selected references contain pertinent information about energy resources and other minerals in Alaska published during 1987 or early 1988. This is only a selection of germane reports from the publications of any agency. Reports by Federal or State agencies can generally be obtained from the agency offices in Alaska, or are available in the Alaska Resources Library, Federal Building, 701 C Street, Anchorage, AK 99513.

The USGS publishes a monthly listing of its own releases, "New Publications of the U.S. Geological Survey," available from the U.S. Geological Survey, 582 National Center, Reston, VA 22092. These listings are compiled in an annual publication, "Publications of the U.S. Geological Survey, 198_." Information about the prices and sources of listed reports is given in these two publications and is also available from the USGS Public Inquiries Offices.

The USBM's central distribution office is the Branch of Production and Distribution, 4800 Forbes Ave., Pittsburgh, PA 15213. Many USBM reports are available from the U.S. Government Printing Office in Washington, D.C., or from the National Technical Information Service in Springfield, Va. USBM reports listed here are available from the USBM library in Juneau; for further information, contact the Chief, Alaska Field Operations Center, 201 East 9th Ave., Anchorage, AK 99501.

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APPENDIX 2.—ROLES OF FEDERAL AGENCIES IN MINERAL PROGRAMS

Department of the Interior

U.S. GEOLOGICAL SURVEY

The mission of the USGS is to develop and interpret the geologic, topographic, and hydrologic data necessary for prudent management of the Nation's minerals, land, and water. The USGS carries out its mission through research that produces geographic, cartographic, and remotely sensed information; geologic, geochemical, and geophysical maps and studies; energy-, mineral- and water-resource assessments; geohazards research, including toxic-waste studies; and participation in multidisciplinary projects, maintaining data bases, and publishing reports and maps.

In Alaska, USGS is active in assessing minerals, including metalliferous and energy resources. Field and laboratory researchers also gather information about domestic petroleum, coal, uranium, and geothermal resources. At the request of land-managing agencies, the USGS provides mineral-resource assessments for land planning, including wilderness studies. Within Alaska, the USGS maintains offices for its Geologic, National Mapping, and Water Resources Divisions. The Branch of Alaskan Geology within the Geologic Division, which is the primary USGS office studying mineral resources in Alaska, is headquartered in Anchorage and has a field office in Fairbanks. Other Alaskan branch geologists are stationed in Menlo Park, Calif. During the summer field season, many USGS scientists from other branches within the Geologic Division conduct mineral-related research in Alaska.

U.S. BUREAU OF MINES

The mission of the USBM is to help assure that the Nation's mineral supplies are adequate to maintain national security, economic growth, and employment. The USBM's Alaska Field Operations Center (AFOC) has headquarters in Anchorage and offices in Juneau and Fairbanks. The AFOC carries out its mission through five programs:

1. Minerals Availability Program—This program is part of a worldwide USBM program responsible for developing the Minerals Availability System (MAS) computer data base and the Mineral Industry Location System (MILS), a subset of MAS. MILS contains basic information about the identification and location of known mineral deposits. MAS is more extensive, containing information about reserve estimates, mineral extraction and beneficiation methodologies, environmental constraints to mining, and cost analyses for selected major mineral deposits. A computer and communications system allows the information to be stored, manipulated, and retrieved as computer-plotted map over-

lays and printouts of MAS/MILS data, enabling rapid and uniform development of cost data for MAS mineral-deposit evaluations. MAS and MILS mineral-deposit data are cross-indexed to several other minerals-information data bases.

2. Minerals Policy and Analysis—This program emphasizes analyses of newly developed and existing mineral data to interpret their significance relative to local and national mineral needs. Assessment of technical, institutional, political, social, and economic factors that affect the supply of and demand for domestic and international minerals is the key to identifying mineral issues.

3. State mineral activities—This program covers minerals-related activities in Alaska and assists in developing and releasing nonfuel-mineral-industry information. The section of State Mineral Activities in Alaska provides USBM direct communication with industry, the Alaska Division of Geological and Geophysical Surveys and the Division of Mining, other minerals-oriented agencies, individuals, and private firms. The USBM's State Mineral Officer collects, analyzes, and reports mineral data and develops information about activities and trends in the mining industry. This program produces the annual USBM Minerals Yearbook chapters and Mineral Industry Surveys.

4. Mineral land assessment—This is the USBM's major Alaskan program, conducted in cooperation with other Federal and State agencies. Mineral assessments are both area and commodity oriented. In support of the Secretary of the Interior's commitment to assess the mineral potential of public lands in Alaska, the AFOC started in 1985 a program to evaluate mineral resources of the mining districts in the State. The program seeks to identify the type, amount, and distribution of mineral deposits; related studies will determine economic feasibility, and legislative effects on mineral development will also be addressed. The USBM is finishing the study of the Juneau Mining District and has started the study of the Valdez Creek Mining District.

A statewide program provides an inventory and specific technical evaluations of the State's critical and strategic mineral deposits on Federal lands that are closed to mineral entry and on lands open to entry that are not of current interest to industry. In addition to locating, mapping, and estimating the size and grade of deposits, the USBM obtains bulk samples for metallurgic research to determine recovery and extraction methods and costs; these studies are undertaken in cooperation with the USBM Research Centers in Albany, Oreg., and Salt Lake City, Utah. These investigations provide reserve estimates of marginal and submarginal deposits in Alaska and its coastal waters.

5. Mining research—Mining research at the AFOC is related to mineral land-assessment activities, as well as providing assistance to alleviate problems in mining, milling, and refining of ore. USBM and university research centers cooperate with the AFOC to solve mineral-utilization problems. Bulk samples of ores from various parts of Alas-

ka have been sent to the USBM Research Centers in Albany, Oreg., and Salt Lake City, Utah, to determine characterization and beneficiation properties related to recovery of the minerals. Beneficiation is the processing of ores for the purposes of: (1) regulating the size of a desired product, (2) removing unwanted constituents, and (3) improving the quality, purity, or assay grade of a desired product.

BUREAU OF LAND MANAGEMENT

The BLM is responsible for multiple-use management of both the surface and subsurface of 23 million acres of the National Petroleum Reserve in Alaska, plus an additional 76 million acres elsewhere in Alaska (see fig. 1). The second figure changes from day to day because of the ongoing program of land conveyance to State and Native organizations. In addition, the BLM administers mineral resources on approximately 100 million acres of other Federal lands, including acquired lands and private lands where the Federal Government has retained the mineral rights.

In December 1984, the BLM revised its policy statement on mineral resources to reflect its continuing commitment to encourage private enterprise to develop domestic minerals in a manner consistent with the need for these resources. Land-use planning decisions will reflect energy and mineral values addressed by mineral-resource assessments. Public lands are generally to remain open to environmentally sound mineral exploration and development.

FISH AND WILDLIFE SERVICE

The FWS provides Federal leadership to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of people. In Alaska, the FWS seeks to accomplish this mission through programs that implement provisions of the Endangered Species Act, Marine Mammal Protection Act, Fish and Wildlife Coordination Act, Rivers and Harbors Act, National Wildlife Refuge System Administration Act, Alaska National Interest Lands Conservation Act (ANILCA), various migratory-bird laws and treaties, and other statutes.

Under ANILCA, 16 refuges in Alaska were created or enlarged to conserve fish and wildlife populations and their habitats, as well as other values. Except for valid rights existing at the time of establishment, these refuges are closed to entry and location under mining laws. The refuges are open to entry under leasing laws; however, they are closed to mining of Federal coal by the Federal Coal Leasing Amendments Act of 1975, and closed to geothermal-resource leasing by the Geothermal Steam Act of 1970. Although many traditional activities have been deemed appropriate for these refuges, other uses, including oil and gas leasing, will be permitted only when such activities are compatible with the purposes for which the refuges were established.

Compatible uses will be determined through a comprehensive conservation planning process under way for Alaskan national wildlife refuges.

NATIONAL PARK SERVICE

In 1916 Congress established the NPS and stated that the fundamental purpose of the Nation's parks, monuments, and other reservations was "* * * to conserve the scenery and natural and historical objects and the wildlife therein and to provide for enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations" (39 Stat. 535). The NPS management policies are based on the concept of conservation and preservation while providing for appropriate enjoyment of natural and cultural resources within the park system. Congress enacted the "Mining in the Parks Act" in 1976, declaring that continued application of the mining laws of the United States to park units conflicts with the purposes for which they were established and all mining operations in park units "* * * should be conducted so as to prevent or minimize damage to the environment and the other resource values" (90 Stat. 1342). The NPS manages mining activities through regulations found at Title 36, Part 9, Subpart A, of the Code of Federal Regulations. These regulations apply to mining-related activities on patented or valid unpatented claims located under the Mining Law of 1872. Proposed plans of operations for these claims must conform to the regulations as further detailed in a "Guide to National Park Service Regulations Governing Mining and Mining Claims" (National Park Service, 1985).

Under the broad authorities granted the Secretary of Interior by Congress (39 Stat. 535) to protect park resources, the NPS has promulgated regulations at Title 36, Part 9, Subpart B, of the Code of Federal Regulations which control all activities in any unit of the National Park System in the exercise of rights to non-Federally owned oil and gas. The Service's non-Federal oil and gas regulations apply in National Park System units in Alaska, and plans of operations are required of operators who, within park units, must access their non-Federally owned oil and gas on, across or through Federally owned or controlled lands or waters.

Department of Agriculture

U.S. FOREST SERVICE

The mission of the USFS is to provide a continuing flow of natural-resource goods, including mineral and energy resources, to help meet national needs and contribute to meeting such needs worldwide. The USFS' responsibility is to encourage and support environmentally sound mineral enterprises on Federal lands under its administration. In managing the use of these resources, the Forest Service's ob-

jective is to minimize unnecessary adverse environmental impacts to surface and cultural features and values which might result from lawful exploration and development operations. This objective is accomplished through the application of reasonable conditions that do not interfere with well planned mineral operations. The Forest Service also provides research information and technology to help with post-mining reclamation. In implementing this policy, the Chief of the Forest Service directed that:

1. A key objective of the minerals program is to encourage and facilitate the orderly exploration, development and production of mineral resources.

2. Minerals, like range, recreation, timber, water, wildlife and wilderness, are one of the multiple uses the Forest Service manages.

3. Forest Service managers must develop a good understanding of the minerals industry, its practices and the minerals laws and regulations.

4. Managers must develop a strong working relationship with the minerals industry.

5. Visibility and interaction with the minerals industry must be increased by attendance and participation of line officers and appropriate staff at industry and professional association activities and meetings.

6. Directories, organization charts and receptionists direct the mineral industry to personnel who have minerals administration responsibilities.

Department of Energy

The Federal Government's mission is to reduce the Nation's vulnerability to disruptions of energy supplies and to mitigate any adverse impacts on the Nation, should a shortage occur. With regard to Alaska, the energy sources currently being addressed by the DOE are fossil fuels (petroleum and coal) and geothermal.

The strategy for responding to petroleum-supply interruptions is to rely on the free market, supplemented as necessary and appropriate with other measures, such as the Strategic Petroleum Reserve. The DOE's Fossil Energy Research and Development Programs are aimed at careful consideration of the alternatives available and the relative chances for success in fostering an adequate supply of energy at a reasonable cost through long-term, high-risk research and development. Alternatives for increasing domestic petroleum supplies include (1) the DOE's Unconventional Gas Recovery Program, which emphasizes the development of advanced technologies for the extraction of natural gas from resources that are classified as unconventional because of unique geologic settings and production mechanisms which are not now well understood; and (2) DOE programs for developing tertiary oil recovery, tar sand, and heavy-oil deposits of the United States.

The purpose of the DOE's Geothermal Energy Program is to develop the technology needed by industry for the use of geothermal resources. DOE research is aimed toward improving methods used to locate, extract, and convert geothermal heat to usable forms of energy. Through DOE funding in Alaska, Federal and State agencies have re-

searched and published several studies of specific geothermal systems.

A further purpose of DOE programs is to generate data essential to the private sector's decisionmaking process, leading to the development of commercial projects.

